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# HEREDITY AND ENVIRONMENT

A Critical Survey of Recently Published  
Material on Twins and Foster Children

BY

R. S. WOODWORTH

*Professor of Psychology  
Columbia University*

*A Report Prepared for the*  
COMMITTEE ON SOCIAL ADJUSTMENT

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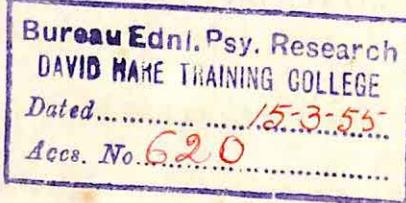


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*The Social Science Research Council was organized in 1923 and formally incorporated in 1924, composed of representatives chosen from the seven constituent societies and from time to time from related disciplines such as law, geography, psychiatry, medicine, and others. It is the purpose of the Council to plan, foster, promote, and develop research in the social field.*

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## *FOREWORD*

DR. R. S. WOODWORTH'S CRITICAL SURVEY of the methods and findings of nature and nurture research was prepared at the request of the Committee on Social Adjustment of the Social Science Research Council. Dr. Woodworth was asked to appraise recent studies of foster children, including studies of twins reared apart, which attacked the problem of the influence of heredity and environmental factors in intelligence and achievement in order that there might be available to the Committee an integrated statement of tested research procedures and resulting knowledge. The Committee has found the report prepared by Dr. Woodworth of great value in clarifying its own thinking, and believes therefore that it will be helpful not only to those engaged in research on twins and foster children but also to all interested in the role of the genetic and environmental factors in human behavior.

Dr. Woodworth has analyzed with his characteristic scientific objectivity and clarity of expression the research results already achieved. He has indicated that these studies are in substantial agreement as to the indispensability of both genetic and environmental factors in mental development and has suggested further research necessary to obtain valid conclusions concerning unsolved crucial problems. He also calls attention to the importance in future studies of integrating the points of view and the methods of research from the fields of anthropology, genetics, psychology, and sociology. His analysis, it is hoped, will stimulate research that will take full account of the deficiencies and shortcomings of past studies as well as of their positive contributions to methodology.

This monograph stems from the Council's interest in a series

of problems which it has for convenience designated by the very broad term "social adjustment." The Committee on Social Adjustment, however, is not endeavoring actually to cover so wide a range. It is seeking rather to discover promising points of penetration. Its initial inquiries are concerned with motivation, predictive methods, and genetic factors, involving primarily cultural anthropology, social psychology, and sociology. A more extensive statement of the interests of the Committee and an account of its work in the beginning stage may be found in a paper by Donald Young published in the *American Journal of Sociology*, "Memorandum on Suggestions for Research in the Field of Social Adjustment."\*

*E. W. Burgess, Chairman  
Frederick Osborn  
A. T. Poffenberger*

\* *American Journal of Sociology*, Vol. XLVI, No. 6, May, 1941, pp. 873-886. Preprints of this paper are available from the Social Science Research Council on request.

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## Heredity and Environment: A Critical Survey of Recently Published Material on Twins and Foster Children

NOTHING is more certain, after a little consideration, than the statement that heredity and environment are coacting factors in the development of any living individual and that both are absolutely essential. If the individual's hereditary potencies could somehow be annulled he would immediately lose all physiological and mental characteristics and would remain simply a mass of dead matter. If he were somehow deprived of all environment, his hereditary potencies would have no scope for their activity and, once more, he would cease to live. To ask whether heredity or environment is more important to life is like asking whether fuel or oxygen is more necessary for making a fire. But when we ask whether the *differences* obtaining between human individuals or groups are due to their differing heredity or to differences in their present and previous environments, we have a genuine question and one of great social importance. In a broad sense both heredity and environment must be concerned in causing individuals to be different in ability and personality, but it is a real question whether to attach more importance to the one or the other and whether to look to eugenics or euthenics for aid in maintaining and improving the quality of the population.

Biologists, because of the very impressive advances in the science of genetics, are quite justifiably inclined to stress the

importance of heredity in the human field. Sociologists and educators, dealing with environmental factors, are properly inclined to emphasize the importance of environment. Psychologists are more divided in their interests and it is perhaps in the field of this science that the controversy between hereditarians and environmentalists is most acute. The progress of investigation has however made it necessary for each party to recognize some merit in the claims of the other. Genetics is forced to admit that the genetic determination of such a human trait as intelligence is exceedingly complex and not easily to be controlled by eugenic measures. Educators and sociologists are forced to recognize the existence of large and obstinate individual differences in every important human trait. It would seem that the rapprochement between the two parties has gone far enough to enable them to join forces in investigation. In any competent study of the problem, at least with respect to human beings, it is necessary to combine a sound knowledge of genetics with a full appreciation of the possibilities of learning and adjustment to the physical and social environment.

Because of the intricate interplay of heredity and environment in human behavior, it is easy to fall into the habit of interpreting all the differences among men in terms either of heredity or of environment. The same body of data will appear to one student as obviously resulting from the one cause, and to another student as quite clearly the result of the other. Musical ability runs in families—a clear instance of heredity to one student, of environmental influences to another. The investigator's task is to produce a body of data which is susceptible to only one interpretation. He wishes to find some situation in which either heredity or environment is uniform, so that the differences which appear there can be attributed to the factor which varies.

Two typical situations in which some separation of the factors occurs furnish the basis for the recent studies covered by the present review. Both are concerned with the development of children, especially their intellectual development. Concentration of effort on this phase of development is due largely to the relatively satisfactory measures available for the intelligence of children. One typical situation is afforded by the mental development of twins, and the other by that of foster children. In connection with the study of foster children, some of the work on children reared in institutional homes will receive brief mention.

The limitations of the review must be recognized. It does not aim to cover all the relevant studies but devotes itself mostly to a few of the recent investigations which have given rise to rather strong claims on one side or the other. The reviewer, from intensive and repeated scrutiny of the published reports, has endeavored to discover what can be accepted as definitely or probably proved, and what must be regarded as undecided pending further investigation.

#### TWINS

Though the investigation of human heredity is beset with difficulties, due in part to the long interval between generations and in part to the lack of well-controlled matings such as are used by the geneticist in his experiments on plants and animals, enough is known to justify the carrying over of certain fundamental laws and concepts. We know that certain human traits are dominant, and certain others recessive. We know that certain traits are genetically simple, and many others complex. We know, too, that in any mixed population—and every human population is decidedly mixed in comparison with the "pure lines" of the geneticist—it is practically impossible for two matings of the same parents, even, to

result in offspring having the same heredity. The chromosomes of the parents are combined differently in their several children. The same parents can produce a considerable variety of children, though the variety is not so great as it is in the population as a whole.

But it sometimes happens that a pair of twins comes from a single fertilized ovum, i.e., from a single ovum fertilized by a single spermatazoon. The embryo in this case, after starting life as a single individual, divides at a very early stage of development and gives rise to two individuals. Now as all daughter cells derived from the same fertilized ovum have exactly the same assortment of genes, the two (or sometimes more) individuals derived from the same fertilized ovum are exactly alike in genic constitution. They are truly identical as far as heredity is concerned. They are often indistinguishable in appearance. They are necessarily of the same sex. These "identical" or monozygotic twins thus afford perfect material for the study of the differentiating effects of environment. Since they are genetically identical any difference which develops between them must be due to some sort of environmental factor.

The remaining twins, called fraternal or dizygotic, are derived from two different eggs or ova, fertilized by two different spermatozoa. Genetically they are no more alike than other siblings. Being conceived and born at the same time does not make them any more alike in heredity. But their environment, both prenatal and postnatal, must on the whole be more alike than that of other siblings.

Among the fraternal twins about half are boy-girl pairs. Since sex is determined by the genes, these unlike-sex fraternals are somewhat less alike genetically than the same-sex fraternals. Any sex-linked characters—characters carried by the sex-determining chromosome—will differ more in unlike-

sex than in like-sex fraternal pairs. Prenatal environment is probably as much alike for a pair of twins whether they are alike or unlike in sex, but the postnatal, social environment is "sex-linked" to some degree. In a boy-girl pair, the boy may be color-blind through heredity, the girl not; while the boy may develop an interest in mechanical engineering, the girl not because of social tradition.

Among pairs of siblings there are thus four classes to be compared: the singly born, the unlike-sex twins, the like-sex fraternals, and the identicals. What is to be compared is the intra-pair resemblance (or difference) of the several classes. If the intra-pair difference is greater for the singly born than for fraternals, the cause must be sought in the environment, prenatal as well as postnatal. If the intra-pair difference is greater for unlike-sex than for same-sex fraternals, the difference may be due either to the genes or to postnatal environment. If the intra-pair difference is greater for same-sex fraternals than for identicals, the fundamental cause must be sought in heredity, though environmental factors may accrue to heredity as interest accrues to legacies of differing amounts. And any intra-pair difference between identical twins must in general be due to some environmental factor. Evidently identical twins provide an excellent base line for a study of hereditary and environmental differentials.

*Twin diagnosis.* There is no longer any doubt of the existence of the two types of twins which we call identicals and fraternals. But as fraternals (like ordinary brothers or sisters) sometimes resemble each other closely, good criteria are needed in order to affect a valid separation in all cases.

It has long been known to obstetricians that some twin pairs are born in a single sac or chorion, and that those so born are always of the same sex and closely resemble each other. The single-sac twins are known to be derived from a

single ovum; they are certainly identicals; but the two-sac pairs are also occasionally derived from a single ovum. Consequently this index is not a sure criterion, even apart from the fact that no record may be preserved of this important detail.

Fingerprints, so much used to identify any individual in the whole population, are often as much alike in identical twins as in the right and left hands of the same individual. But even this criterion, taken alone, sometimes leaves the investigator in doubt. Modern investigators refuse to depend on any single criterion. The best evidence of monozygosity is derived from comparing the twins in quite a number of anatomical traits such as are determined by heredity without being too common in the population. If the chances of two siblings being alike in one such trait is 1 in 2, the chances of their being alike in ten such traits is 1 in over 1000. Among the traits used are the exact color of eyes and of hair, the form and texture of the hair, the close resemblance of the faces, the shape and arrangement of the teeth, the color and texture of the skin; and identicals must of course belong to the same blood group (Newman, 1940).

The brain-wave pattern which differs notably from individual to individual appears to be identical in identical twins, though not in siblings (Davis & Davis, 1936; Gottlober, 1938). Quite possibly identicals could be separated from fraternal on the basis of close resemblance in an array of physiological and psychological tests, but such a procedure would involve circular reasoning in many problems of heredity and environment. For our purposes a physical diagnosis is the first requirement.

*The sampling problem.* When the question at issue hinges on a comparison of fraternal with identical twins, there is danger of error from unrepresentative samples. Twins who are

much alike attract attention and are brought to the investigator's attention while those that differ considerably in appearance and behavior may be overlooked. It is said that fraternal twins who are quite dissimilar often lose track of the fact that they are twins and, at least, are not known to be twins by their associates. A questionnaire is almost sure to yield a sample overloaded with fraternals that are similar and thus to yield an underestimate of the average difference between fraternals. Probably the most adequate method of securing an unbiased sample is to start with the birth records of a certain district for a certain period and to trace as far as possible all of the twins who appear in the record (von Verschuer, 1940). A fairly adequate method is to start by inquiring in certain schools or institutions for all individuals who have twin brothers or sisters, and then to locate and examine all of these twins (Rosanoff, Handy & Plessert, 1937).

Identical twins separated in infancy have in several of the known cases discovered their relationship because of their striking similarity in appearance. If similarity in mental traits were closely correlated with similarity of appearance, the inclusion of these cases would bias the sample toward mental similarity; but the actual cases show on the whole no greater mental similarity than those discovered in other ways (Newman, Freeman & Holzinger, 1937).

*The logic of twin studies.* Scientific use of twins was one of Francis Galton's pioneer ventures (1875, 1883). Without having exact methods available for the diagnosis of identicals and same-sex fraternals, Galton was of course well aware that some twins were very much alike, while other pairs showed no more resemblance than other siblings. He sought by case histories to determine whether the twins that were very much alike as young children grew to differ, and whether pairs showing a large initial difference became more alike as they grew up.

Either effect might be laid to environment, but Galton could obtain very little evidence of either. Sometimes twins that were originally closely alike diverged because of illness affecting one of the pair, but otherwise they remained alike up into adult life. Twins originally quite different became more accentuated in their differences rather than more alike.

Galton's logic is perfectly clear in respect to identicals: if they are unlike or grow more unlike, the cause must be sought in the environment. With respect to twins originally much unlike, however, Galton's apparent assumption that they should grow more alike in the same home, i.e., that a common environment acting on differently endowed individuals should make them more alike, if it had any effect at all, is not self-evident. It was accepted by some of the earlier successors of Galton, but just the opposite assumption has seemed more reasonable to some investigators. In height and weight fraternal twins often grow more unlike as they approach maturity. If one has the genes for a tall man and the other for a short man, equal nutritive opportunity is not going to prevent this genetic difference from manifesting itself. Unlike individuals may be expected to respond differently to the same environment, and this is a reasonable expectation in regard to all kinds of ability and propensity. The observed divergence of fraternal twins can therefore be attributed to heredity. But it is also possible to attribute it to environment. The same home is not the same environment to children of very different characteristics. The same dinner table is not the same environment to the hearty eater and to one with a poor appetite; and the effective nutritive environment is evidently not what is set before you, but what you eat. Such considerations should lead to longitudinal studies of developing fraternal twins, but they indicate that not much capital can be made for either heredity or environment from the mere fact that fraternal twins tend to grow more unlike.

The "twin method" developed in Germany (Siemens, 1924; see Wilson, 1934) and much used there in the last two decades for the study of heredity and environment, consists in comparing the average resemblance of identicals with that of fraternals. The difference between identicals, due to environment alone, is compared with the difference between fraternals, due to heredity and environment. The difference between fraternals is greater in practically every trait that has been studied (Gottschaldt, 1939). Where it is very much greater, heredity is an important factor in causing individuals to differ, but where it is only a little greater, the environmental factor is the stronger. Mathematical formulas have been developed for estimating the relative importance of heredity and environment in respect to any given trait. These formulas have rested on the assumption that the environment is as similar for a pair of fraternals as for a pair of identicals. Probably the assumption is not far wrong in respect to the somatic characters that have usually been studied, since the social environment has little effect on these characters; and the method has yielded results that are apparently sound and sometimes quite important—as in regard to susceptibility to tuberculosis, etc. But intelligence and personality may well be much more dependent on the social environment, and there is evidence, to be presented shortly, that the social environment differs more for a pair of fraternals than it usually differs for a pair of identicals. The excess intra-pair difference of fraternals is therefore due to a complex of factors rather than to heredity alone; but with a suitable revision of its logic the "twin method" may still be of use in studies of intelligence and personality.

"Co-twin control" is the name given by Gesell & Thompson (1929) to a third method of utilizing twins. This method deals only with identicals and its logic is relatively plain and simple. Since identicals are alike in heredity, any difference that

develops between them must be due to environment. (Exception must be made for certain asymmetries such as right and left handedness. As a single individual shows these asymmetries, it is not strange that a split embryo will sometimes develop them.) Co-twin control is applicable in various ways. To discover whether imitation plays any part in the child's assumption of the erect posture, one of a pair of identical babies might be prevented from seeing people in that posture until his twin was beginning to stand, the question being whether the isolated twin would stand on his own initiative. This particular experiment has perhaps not been tried but a variety of analogous experiments done in this country and in Russia have been fruitful enough to indicate that the method would be well worth using on a large scale. It was being used on a large scale in the USSR when some political interference put a stop to the project (Levit, 1935; Luria, 1936; Muller, 1935).

The study of identical twins reared apart belongs under this general head. If they develop differently, environmental factors are responsible, though usually it is not easy to discover the exact factors that have produced the difference in intelligence or personality. If separated identicals show greater intra-pair differences than unseparated, again environment is responsible, and again we cannot usually put our finger on the important differentiating factor in the social environment. The whole method could be tuned up by giving it a more experimental slant.<sup>1</sup>

*Social environment of identical and fraternal twins.* Research on the effects of environment may well start with an attempt to discover factors that might probably cause a pair of twins to differ. From a rather external point of view twins,

<sup>1</sup>For a review of methods and recent results in twin study, with bibliography of 193 titles, see Carter (1940).

whether identical or fraternal, have the same environment. They live in the same home, probably attend the same school, and are exposed to the same neighborhood, community and cultural influences. So it was not unreasonable for the inventors of the "twin method" already discussed to assume that the environment was as much alike for fraternals as for identicals. Stocks (1930) was perhaps the first to question this assumption. As he says, it "may involve a fallacy in that many dizygotic twins are very different in general body build, healthiness, tastes and temperament so that they naturally tend to subject themselves, or be subjected, to differences in nurture to a greater degree than monozygotic twins who have usually the same needs, tastes and inclinations and are rarely seen apart during childhood." The inference is that the environment differs more for fraternals than for identicals.

In the same year Holmes pointed out the possibility "that fraternal twins by virtue of their differences soon get into different relations with their environment and come to experience very unlike reactions from their associates." That Stocks and Holmes were correct in suggesting that environment was more alike for identicals than for fraternals was demonstrated by P. T. Wilson (1934) by use of a questionnaire which was answered by 70 pairs of identicals, 69 of like-sex fraternals, and 55 of unlike-sex twins in California. To the question, how much they had been separated, identicals reported much less separation than fraternals; 43% of identicals as against 26% of like-sex fraternals had never been separated for more than a day. As to companions 76% of identicals as against 52% of like-sex fraternals reported having the same chums. Also identicals were more alike in dress and food preferences and in liking for games and studies. In practically every comparison a larger percent of identicals were alike. Wilson concludes that "in many re-

spects the identical pairs lived under more similar conditions than the fraternal. This fact must be attributed ultimately to the influence of their heredity which led, or forced them to 'select' more similar environments."

This statement of Wilson deserves emphasis. Unless the environment is extremely limited and rigid the individual has some choice, and according to his native tendencies he will choose one or another *effective* environment within the range of the objective environment. Within the same home one child responds more to the father, another to the mother, one more to the indoor life and another to the outdoor, one more to the mechanical things about the place and the other more to the musical opportunities. Within the same home, then, two children may have very different effective environments, for the reason, at bottom, that they differ genetically. Quite possibly this is the most important fact in the whole problem of heredity versus environment.

The *interaction of heredity and environment* is at least one important consideration in the investigation of individual differences. Shuttleworth (1935) showed the necessity of taking account of interaction in any statistical approach to the problem. He had in mind particularly the fact that parents providing good heredity for their children will on the whole provide them also with good environment. To the degree that family heredity and family environment are positively correlated, the children of a community will differ more than can be accounted for by heredity and environment considered separately. It must be equally true that children in the same family develop differently because of the interaction of heredity and environment, rather than because of either factor alone or even because of the two factors taken separately. The children differ by heredity to start with, and because they differ in native capacities and propensities they are treated

differently and respond differently to the opportunities offered by the environment.

We may accept the conclusion that the environment differs more for fraternals than for identicals. Another question is whether the environment is completely the same for identicals. Even in identical pairs that are very harmonious and always together, a sort of division of labor or differentiation of roles is often apparent, as von Bracken has shown (1936). One child is the Aussenvertreter, the "outside representative" or foreign minister of the pair. He answers when a question is addressed to the pair, he does most of the talking to a stranger, he opens the door for a visitor, accepts a present that is held out to the pair, and appears to have more interest than his twin in other people. Other observers (Schiller, 1937; Newman, Freeman & Holzinger, 1937) have reported similar differences between identicals. Even when the twins behave almost indistinguishably, their mother will often insist that they are very different in certain respects, that one is girlish and the other boyish, or that one is the leader and the other the follower. How can such a difference arise? Sometimes it is traceable to unequal size or vigor resulting from prenatal causes. Sometimes it may be imposed by the parents who are anxious to discover any distinguishing mark. But a differentiation of role may arise simply as a measure of economy and convenience. Less friction within the pair and more success in dealing with other people will result if it is understood who shall take the lead. The more harmonious the pair, the more we might expect some division of labor to occur. In many cases, observers report, the leadership of an identical pair is achieved not by a struggle for dominance but by mutual consent.

The important question for us is whether this differentiation of roles results in a divergence of abilities and person-

ality traits. Slight indications of a corresponding differentiation of personality have been reported by von Bracken and his associates. In adolescence identical twins often select different occupations (Meumann, 1935; Bouterwek, 1936). A pair of girl identicals after finishing their schooling were taken into their father's business office, where one liked the work and the other not. The latter by mutual consent took over the family housekeeping which she liked. One twin showed business ability, the other housekeeping ability. The twins meanwhile remained closely attached to each other. Such a difference though manifesting itself first in early adult life may have been developed through childhood as a result of some less obvious differentiation of roles. But the conclusion is speculative in the absence of developmental studies of twins.

Such differentiation of roles as has been observed would probably cause identicals to differ in certain special abilities and personality traits, rather than in general intelligence or in temperament.

*Prenatal and natal environment.* Reference to this period of development may appear superfluous in a study concerned with heredity and the social environment. Life in utero is so sheltered, so we might suppose, that no differences between twins could possibly be produced by environmental factors operating before birth. But this supposition is far from correct. The unborn infant requires a large supply of suitable nourishment and of oxygen and can be injured by toxic substances from the mother. Twins are competitors for the maternal supply of nourishment and not infrequently one twin loses out in the competition and dies before birth or is underdeveloped. Identicals as well as fraternals are exposed to this danger. And before the child is "brought into the world" he has still to undergo the hazards of birth. He may suffer from a

brain injury during difficult labor, or he may suffer from asphyxia, and the harm may be permanent. Twins are likely to be prematurely born, small and delicate and especially susceptible to birth injury. So it often happens that one of an identical pair is injured and permanently handicapped. Failure to take account of these possibilities may lead to serious error in the interpretation of twin data, and therefore it will not be amiss to consider a recent investigation that lays much emphasis on this type of environmental factor.

Rosanoff, Handy & Plessert (1937) were concerned primarily with the etiology of mental deficiency, so far as it could be revealed by a study of pairs of twins, one at least of each pair being mentally deficient. Their sampling method has already been indicated. In the public schools of California and in institutions for the feeble-minded in several states they found 366 mentally deficient individuals known to have twin brothers or sisters. They located these brothers and sisters and determined their mental condition. In many cases the twin brother or sister was found to be feeble-minded or to show some other abnormal condition such as epilepsy, birth paralysis or behavior difficulties. If the twin brother or sister was normal, the pair was said to be "discordant," otherwise "concordant." Out of 126 pairs of identicals there were 11 pairs in which one twin was feeble-minded and the other normal; that gives 8.7% of discordant pairs. The normal twin serves as a control, proving that the defective one had the genes for normality and that the defect must have been due to some environmental factor. As the case histories indicated that the defect had existed from early childhood, the etiological factor probably belonged under the head of prenatal or natal environment.

In the same way the percent of discordant pairs was obtained for same-sex fraternals and for unlike-sex fraternals,

and a figure for siblings was taken from another investigator (Hummer, 1932). The approximate percents are presented in an adjoining table.

*Percent of Discordant Pairs*

Normal twins and siblings of mentally deficient individuals  
(Rosanoff, Handy & Plesset, 1937)

<i>Number of pairs</i>	<i>Relationship</i>	<i>Percent discordant</i>
126	Identical twins	9
93	Same-sex fraternals	39
139	Unlike-sex fraternals	53
	Siblings	84

*Of the unlike-sex pairs,*

Both twins were abnormal in	47%
The male alone in	35%
The female alone in	17%

Assuming as the authors think it safe to do from their case histories that postnatal factors play but a minor role in producing mental deficiency and that "the bulk of mental deficiency exists from birth," they compare the percents given in the table and ask the following questions.

1. Why should there be any discordant pairs of identicals? Answer (as already given): Because of prenatal and natal factors.
2. Why should there be many more discordant pairs of same-sex fraternals than of identicals? Answer: Because the fraternals differ in heredity.
3. Why should discordance be more common in unlike-sex than in same-sex fraternals? And why should the male twin in such pairs be mentally deficient more often than the female? Answer: Probably because of some sex-linked factor in early development, the same, perhaps, that causes the excess of stillborn males.
4. Why should discordance be so much more common in singly born siblings than in fraternal twins? Answer: Because

of prenatal and natal factors, the same factors that cause mental deficiency to be more common among twin-born than among singly born children. Prematurity and underweight at birth, with resulting brain injury, are more common in twins.

From certain additional data the authors show that these conditions that favor birth injury are very common in the histories of mentally deficient individuals—about eight times as common, they estimate, as in the general population. All the evidence seems to them to point to the great importance of these prenatal and natal factors, and leads them to believe that “scarcely more than one-half of the cases of mental deficiency are of hereditary origin.”

Since the investigation under review included no systematic study of the postnatal environment, social and educational, the authors quite possibly overestimated the importance of the prenatal and natal environment. Other studies (Strauss, 1939; Kephart, 1939) indicate that in children showing no sign of brain injury suitable education can produce an appreciable intellectual improvement. Even a small gain would take many individuals out of the class of feeble-minded into the borderline group at least. But the authors last cited and many others admit the existence of a large group of mentally deficient individuals who are such because of prenatal and natal factors.

Rosanoff and his associates believe that birth injury is much more common than has been recognized. The injury may not be noticed at the time and yet may later give rise to some degree of mental deficiency. “Hereditary factors determine merely the potentially maximal intellectual development that may be obtained by a given individual.” This full potentiality will not be realized except under favorable conditions. There must not be any prenatal condition leading

to underdevelopment of the brain. There must be no cerebral injury during birth. In infancy and childhood there must be no serious head injury or disease affecting the brain. And on the positive side there must be such home, school and other environment as will properly stimulate intellectual development. "It is a question whether all these conditions are fulfilled for more than a limited minority of individuals in contemporary society."

The authors are thus led to formulate the concept of "relative mental deficiency." An individual may have normal or even superior intelligence and still be relatively deficient in that he has not realized his full genetic potentiality. When for example the authors found a pair of identical twins having intelligence quotients of 150 and 118, they argued that the one with IQ 118 was relatively deficient since his hereditary potentiality must have been the same as his twin's. The same argument would apply to any pair of identical twins showing a considerable difference in ability, and in such a case the possibility of birth injury in one twin needs to be excluded before the pair can be used in demonstrating the effects of social environment. In crucial cases a neurological examination or at least a good medical history would seem to be essential.

*Physical and intellectual resemblance of twins.* Of the numerous studies of twins reared together, which in general have yielded very similar results, we will take notice of one of the most complete and accurate, that of the University of Chicago investigators, Newman, Freeman and Holzinger (1937), respectively a geneticist, a psychologist and a statistician—a very desirable combination for such a study. They measured identical and fraternal twins reared together, and identical twins reared apart. A table showing the intra-pair differences and correlations for each of these three classes will

be discussed at this point so far as concerns the twins who were reared together. For a much sharper statistical analysis than can be attempted here reference is made to the critical review by McNemar (1938) and the reply of Holzinger (1938).

#### *Differences Between Twins*

(Newman, Freeman & Holzinger, 1937, pp. 72, 344)

	<i>Fraternals</i>	<i>Identicals reared together</i>	<i>Identicals reared apart</i>
Stature	4.4 cm	1.7 cm	1.8 cm
Weight	10.0 lb	4.1 lb	9.9 lb
Binet IQ	9.9 points	5.9 points	8.2 points

#### *Correlations Between Twins*

(Ibid., pp. 97, 347)

	<i>Fraternals</i>	<i>Identicals reared together</i>	<i>Identicals reared apart</i>
Stature	.645	.932	(.969)
Weight	.631	.917	(.886)
Binet IQ	.631	.881	(.767)

*Note.* These correlations (except those in parentheses) have been corrected for age, and the last value in the table (.767) has been corrected for range, according to a suggestion made by McNemar (1938) and accepted by Holzinger (1938). Such correction is necessary because the separated identicals, taken as a group, were rather uniform in intelligence, their distribution giving an SD of 13.0 points as against 17.3 for the identicals reared together.

From these differences and correlations (and from the whole distributions) the authors reach the conclusion that intelligence is more affected (differentiated) by the environment than are such physical characteristics as height and weight. In other words, the share of the environment in the production of individual differences is greater in respect to intelligence than in respect to height and weight. The share of the environment is represented by the intra-pair difference of identicals (who are equal in heredity), while the difference between fraternals represents the combined effect of heredity

and environment. The argument is that of the "twin method" already discussed and is subject to the same limitations. But for a moment let us consider the figures as they stand.

Consider first the table of differences. The fraternals always differ more than the identicals, but they differ 2.6 times as much ( $4.4/1.7$ ) in stature and 2.4 times as much ( $10/4.1$ ) in weight, as against only 1.7 times as much ( $9.9/5.9$ ) in intelligence. Or, inverting these ratios, we say that the share of environment in producing the difference between fraternals is 39% in stature and 41% in weight, as against 60% in intelligence. On the face of the returns environment counts for much more in intelligence than in height and weight—as would indeed seem quite reasonable.

The argument breaks down, however, when we take account of the error of measurement which is relatively large in the case of the IQ. Retest of the same person within a week usually shows some shift of score up or down, averaging about 5 points of IQ. This amount is a fair estimate of the chance error of measurement affecting the obtained difference in IQ between two individuals. Identicals reared together, it will be seen, differ only a little more than this. Making allowance for this chance error we reach an estimate of 3.1 points net difference between identicals, and of 8.5 points net for fraternals. The fraternals then differ 2.7 times as much as the identicals; or the share of environment is  $3.1/8.5 = 36\%$ . There are chance errors of measurement in the physical traits, too, but they are quite small and allowance for them would not change the ratios very much. With allowance made for errors of measurement, then, the "share of environment" is approximately the same for intelligence as for the physical traits considered.

The same conclusion can be drawn from the table of correlations. When allowance is made for the error of observation

the IQ correlations are raised to about .66 for fraternal and .93 for identicals. Thus the resemblance of fraternal was about the same in the three traits, the resemblance of identicals much higher but about equal in the three traits. The data afford no ground for making any distinction between the three traits, as concerns the shares of heredity and environment.

Having convinced ourselves (in considering the "twin method") that the environment differs more for fraternal than for identical twins, we cannot derive much information from a comparison of the results from the two classes of twins. From the results on identicals we can infer that environment can cause a certain amount of difference between individuals of the same heredity, and that the differentiating effects of environment are about equal in physical traits and in intelligence, when the identicals are reared together.

As to fraternal, we know that they differ more or less in heredity, and that their effective environments differ in (partial) conformity with their difference in heredity. Because of this combination of factors, fraternal differ more than identicals and they seem to differ about as much in intelligence as in physical traits. The interaction of heredity and environment in the case of fraternal leaves little chance for separating the two factors and assigning to each its share. There is really little point in comparing fraternal and identicals; there is more point in comparing fraternal with ordinary siblings, since the hereditary difference should average the same while the environment would on the whole be more alike for twins than for other siblings.

*Identical twins reared apart.* The first pair of separated identicals to be tested and carefully studied was that reported by H. J. Muller (1925). The principal series of such pairs was gathered with much labor over a period of years by the

Chicago group, Newman, Freeman & Holzinger, and reported in their book on "Twins," 1937. They discovered, measured and tested 19 pairs of identicals who had been separated in infancy or early childhood and reared in different families and communities. Another pair has been added by Gardner & Newman (1940). And a British pair, reared apart up to the age of nearly ten years, has been studied by Saudek (1934). Diagnosis of monozygosity was carefully made in all these cases. The correlations and average differences for the 19 pairs of Newman, Freeman & Holzinger have been included in the tables on p. 19. Inclusion of the additional cases would make only slight differences in these tables.

The following table presents certain data for each of the separated identitals. With regard to prenatal and natal environment, the case histories of the pairs numbered 1 and 8 suggest the possibility that the twin with lower IQ in each of these pairs got a poor start and perhaps suffered a slight but permanent handicap.

For the most part the environments in which the twins of the same pair were brought up did not differ extremely—not more than would be true of children brought up in the same community. In a few instances the difference was rather large. The greatest difference in education occurred in the case of two girls one of whom was reared in a good farming region and who went through college and became a school teacher, while her twin grew up largely in the backwoods and had only two years of regular schooling. This girl however obtained employment later in a large city and became a general assistant in a small printing office where she performed a variety of duties including typesetting and proofreading. On being tested her IQ came out at 92, while that of her college-educated twin sister was 116. This difference of 24 points in IQ was the largest found in any case.

*Some Data from Identical Twins Reared Apart*  
 (Newman, Freeman & Holzinger, 1937; Muller, 1925; Gardner &  
 Newman, 1940; Saudek, 1934)

Case Number	Sex	Age at Separation	Age at Testing	Environmental Differences			IQ Difference
				1. in Years of Schooling	2. in Estimated Educational Advantages	3. in Estimated Social Advantages	
11	f	18 mo.	35	14	37	25	24
2	f	18 mo.	27	15	32	14	12
18	m	1 yr.	27	4	28	31	19
4	f	5 mo.	29	4	22	15	17
12	f	18 mo.	29	5	19	13	7
1	f	18 mo.	19	1	15	27	12
17	m	2 yr.	14	0	15	15	10
8	f	3 mo.	15	1	14	32	15
3	m	2 mo.	23	1	12	15	- 2
14	f	6 mo.	39	0	12	15	- 1
5	f	14 mo.	38	1	11	26	4
13	m	1 mo.	19	0	11	13	1
10	f	1 yr.	12	1	10	15	5
15	m	1 yr.	26	2	9	7	1
7	m	1 mo.	13	0	9	27	- 1
19	f	6 yr.	41	0	9	14	- 9
16	f	2 yr.	11	0	8	12	2
6	f	3 yr.	59	0	7	10	8
9	m	1 mo.	19	0	7	14	6
Muller Gardner & Newman	f	1 mo.	30	9	?	?	- 1
Saudek	m	1 mo.	20	0	?	?	$\pm$ 4

*Note.* The estimated differences in educational and social advantages are in "points" with a maximum possible of 50. From the case material each of five judges rated the environmental differences between every pair of twins on a scale of 10 points, and the figure given in the table is the sum of these five ratings. A minus sign before an IQ difference means that the twin who received the higher rating for educational advantages obtained the lower IQ.

Another pair of young women had been separated in infancy and one had been reared on a good farm and had gone to school only for the eight grades, while the other had lived

in a small town, gone through high school, studied music and engaged in clerical work. The town girl's IQ as determined by the tests was 106 while the farm girl made only 89. In spite of this large difference in the tests the country girl gave the impression of being fully as intelligent, or competent, as her twin sister.

A pair of young men from Tennessee had been brought up, the one in a small town where he went through high school and engaged in business, the other back in the mountains with irregular schooling amounting to eight grades at the most. Tested at the age of 25, the mountain boy obtained an IQ of 77, the town boy of 96.

*Identicals reared apart—treatment of data.* There are two main ways of treating the data from separated identicals. The more obvious way is to compare them with identical twins reared together, as can be done either by comparing the mean difference between twins in the one class with the corresponding difference in the other class, or by comparing the correlation between the paired individuals in the two classes. Either method is essentially a study of intra-pair variance. The difference has to be taken without plus or minus sign, because in the identicals reared together there is no known differentiating factor to give either twin a distinctive place in the pair. Because the intra-pair difference is taken without sign, it needs to be corrected for the chance error of observation, as was done on page 20.

The other way of treating the data is to look for environmental factors that might differentiate the members of a separated pair and to determine whether a given factor has produced a significant difference between the favored and the disfavored twins taken as a group. For example, if it can be seen that one twin has received better educational advantages than the other, in each pair, we can determine whether there

is a significant difference in IQ in favor of the better educated twins. Here each difference has a sign, plus or minus, and the average difference (account being taken of the signs) does not need to be corrected for chance errors of observation. It is important to notice this distinction between the two methods of treatment. Suppose the mean difference between identicals to be 5 points IQ; this difference does not exceed the error of observation and therefore does not indicate any true difference. But suppose, in a sample of identicals reared apart, the better-educated twin averages 5 points higher in IQ than the other. This may be a significant difference (given an adequate sample), for the chance errors of observation would not favor either class of twins as against the other class.

Taken without regard to sign, the average IQ difference between separated identicals is 7.6 points. Correction for chance errors of observation would bring this difference down to 6 points net, a figure to be compared with the estimated net difference of 3 points between identicals reared together, and of 15 points or more between children paired at random from the same community. It is probable, then, that environment did make these separated twins differ in tested intelligence, though not to any such extent as obtains among the children of a community.

When the IQ differences are averaged with account taken of sign, the twin having the advantage in educational opportunities usually surpasses the other. On the average the IQ was 6.0 points higher for the better-educated twin. This difference is statistically reliable, being over 3 times its Standard Error. It seems safe to conclude that when one of a pair of identicals has been afforded better educational advantages than the other, the better-educated one will on the whole do better in the intelligence tests.

However, there were only 6 pairs differing very much in

the amount of formal schooling received. These 6 show an average superiority of 13 points in IQ. The remaining pairs show only a small and unreliable IQ superiority for the better-educated twin (3 points on the average, and only 1 point when the two cases of possible prenatal handicap are omitted). It appears, then that rather a large educational advantage is required to give any dependable superiority in tested intelligence.

Years of schooling are of course not an adequate measure of educational advantages. Newman and his colleagues endeavored to do a little better by going over the case histories of their 19 pairs and estimating the educational difference between the twins by aid of a rating scale. The ratings are given in our last table. There is a correlation of +.79 between the estimated educational difference and the obtained difference in IQ. This substantial correlation depends largely but not wholly upon the few pairs whose education was very unequal.

The authors of this extensive study, when they express themselves separately and independently regarding the findings in respect to intelligence, differ somewhat in emphasis, but two of the three, at least, agree that rather large environmental inequality is needed to produce any reliable difference in intelligence.

Freeman (1937) says: The data indicate "that environment may affect all kind of traits, intellectual, temperamental, and social; that this influence is large enough to be of the greatest importance; and that human nature may be improved or debased to a degree which many have thought impossible."

Holzinger (1935) says: "Moderate environmental differences produce inappreciable effect upon twin characters . . . relatively great environmental differences must be present to produce noticeable effect upon traits such as here studied."

Newman (in Gardner & Newman, 1940) says: "Where environmental differences are rather large fairly large differences result. Possibly, and even probably, we are dealing here with a matter of thresholds of influence and that, unless a certain threshold of difference is reached, the organisms do not respond differentially. . . . The geneticist of the group of authors must confess . . . that throughout the whole study of identical twins reared apart he was much more impressed with the very great intra-pair similarities of these twins, after they had been exposed to all sorts of environmental differences, than he was with their differences. . . . Nevertheless . . . fairly large environmental differences do modify physical, mental and temperamental traits and produce proportionately large differences even between hereditarily identical individuals."

*City and country environments.* In 8 of the 21 pairs of separated identicals, one child was reared in the country and the other in a town, large or small. These cases afford a small amount of data for testing the hypothesis that the country is a less stimulating intellectual environment than the city or town. Three of these pairs are included in the list of those who had very different amounts of schooling, and in their cases the country child's IQ was 17, 19, and 24 points lower than the city child's. In the other five pairs, the amount of schooling was the same for both city and country child, and the IQ difference in favor of the city child was 10, 8, 6, -1, and -1 points, averaging 4.4 points. For the 8 pairs taken together the average difference in favor of the city child is 10 points, not far from the average usually found in comparing samples of city and country children, but as far as the evidence goes the difference is mostly due to schooling.

The question whether the difference usually found in the intelligence of city and country children is due to a selective

migration of the better stocks to the city, or to a difference in environmental stimulation, or simply to inadequate tests so constructed as to favor the city children, is obviously one of great importance. The literature on this question will not be reviewed in this report. It is worth noting that, while most studies have shown an average difference in favor of the city child, and while some studies have found evidence of a selective draining off of a disproportionate number of the more intelligent individuals into the cities, the recent testing of all the children who were born in Scotland on certain days in 1926 showed no difference between city and country children, on the average. This is one of the fairest samplings ever made for intelligence testing. The author makes the point that the rural Scottish children suffer no handicap in respect to schooling since the country schools are supplied with well-trained teachers (Macmeeken, 1939).

*Environment and personality.* Newman, Freeman & Holzinger attempted to obtain some measures of temperament and personality but the available tests were not very good as is shown by the fact that these tests yielded no greater differences between fraternals than between identicals reared together. According to the tests, the identicals reared apart differed no more in personality than identicals reared together. Nor was there any measurable relationship between difference in social environment affecting the twins of a pair and amount of personality difference. The general impression of the investigators from personal contact with the separated identicals was to the effect that social attitudes were much dependent on the environment, while there was scarcely any effect on the temperament and deeper traits of personality (Newman, 1940, pp. 182, 193-196). In some cases there were personality differences corresponding to what one might expect from the known environmental differences. The college-educated

schoolteacher had a polished manner, was careful of her personal appearance and sought to produce a favorable impression; while her twin, the little-educated assistant in the printing office, was "all business, without social charm or concern about how she impressed others." The farm girl was muscular, masculine and deliberate, while her city-bred twin was "far more excitable and responsive, almost neurotic." But the young man from the mountains who had engaged in a good deal of illegal activity appeared to be identical in personality traits with his twin, the steady, respected citizen of a small town. Both were rather individualistic and stubborn, but expressed these traits differently in conformity with their respective social backgrounds. In the German studies of criminals (Lange, 1930, 1937; Kranz, 1936, 1937) the "equivalence" of certain forms of illegal behavior with certain forms of legal behavior has been pointed out. They are equivalent in the sense that both identical twins may be behaving according to the same inherent tendency, though the form of the behavior is quite different from the social point of view.

*Conclusions from the twin studies.* If we return now to the results on the intelligence of identical twins reared apart, two conclusions seem probable even though the sample is still far too small to make either conclusion sure. In the first place, radical differences in education can create substantial differences in intelligence, so far as intelligence is measured by our tests. Differences in IQ as great as the standard deviation of the population have been found in several instances, corresponding to large differences in educational advantages. We can conclude that the educational environment, taken in a broad sense, has a marked effect on such intelligence as we are now able to measure.

In the second place, however, the differences between identical twins reared apart are remarkably small except in

those cases where the contrast of educational advantages was very great. For the majority of the separated identicals the IQ difference was no greater than for identicals reared together. When individuals of identical heredity are subjected to environments differing about as much as those of the children in an ordinary community, such identical twins differ much less than the children of such a community. Therefore the differences found among the children of an ordinary community are not accounted for, except in small measure, by differences in homes and schooling. To repeat—if the differences in intelligence found among the children of a community were mostly due to differences in home and school environment, these differences would remain almost in full force even if the heredity of all the children were made identical. But when a trial is made of this hypothesis by placing identical twins in different families not too different in environment, the twins show only a small fraction of the difference found in the community at large.

These two statements—(1) that differences in environment can produce substantial differences in intelligence, and (2) that the differences actually present in a community are *not* due mostly to differences in environment—may appear mutually contradictory. That they are not contradictory has been emphatically pointed out by several students of the nature-nurture problem. For example:

Thorndike (1914): "If the environments are alike with respect to a trait, the differences in respect to it are due entirely to original nature; . . . if the original natures are alike with respect to a trait, the differences in respect to it are due entirely to differences of training. . . . Many disagreements spring from a confusion of what may be called absolute achievement with what may be called relative achievement. A man may move up a long distance from zero and nevertheless

less be lower down than before in comparison with other men" who have moved up still farther. "The commonest error . . . is that of concluding from the importance of . . . heredity that education and social control in general are futile. . . . To the real work of man for man,—the increase of achievement through improvement of the environment,—the influence of heredity offers no barrier."

Schwesinger (1933): "Elimination of the lower mental levels, as advocated, or elimination of the upper mental levels, as feared, by present eugenists, would greatly reduce the biological range of native brightness. If the biological factor in variation is thus restricted, the relative importance of the nurture factor will, *ipso facto*, become greater. . . . Equalization in educational opportunity, i.e., decreasing the nurture variable, would render more significant the nature variable in producing variance in measured intelligence."

Shuttleworth (1935): "The data of Burks indicate very clearly that inter-family environmental differences account for a much smaller proportion . . . of the variance . . . in intelligence than do hereditary differences. . . . The inferiority complex which many educators and environmentalists have created for themselves by the misinterpretation of these and similar data is a most bizarre phenomenon. It does not follow that the general level of the environment is a relatively unimportant factor in determining the general level of intelligence, but only that environmental differences are relatively small in comparison with hereditary differences in determining individual differences in intelligence. Even if environmental differences accounted for zero percent and hereditary differences accounted for 100% of the individual differences in intelligence, it would still be true that the general level of the environment would be a most important factor determining the general level of intelligence." During the past century

there has occurred a notable "leveling up" of the environment in respect to education, public health, economic conditions, etc., and consequently the share of heredity in the remaining individual differences has been increased.

*Needs for further research on twins.* The sample of identical twins reared apart, the most important group for scientific purposes, needs to be enlarged, as it probably will be without concerted effort, now that the interest in this line of study has become widespread. Given a long time-perspective, an organized group could improve this line of investigation by working through placement agencies. Whenever a pair of twins is separately placed, diagnosis of the kind of twin should be made, the birth history and any signs of birth injury should be included in the record, and the twins should be followed along with close attention to environmental differences. Little that is definite is known of the relative importance of numerous environmental factors that vary from home to home and from one community to another. Even without separate placement of identicals, the method of co-twin control could be made to answer a good many questions regarding the value of this or that factor that holds some promise for the improvement of the population.

Identical twins reared together but separated in adult life and following quite different lines of work might throw light on a question that has not been considered in these studies. Does intelligence (so far as measured by the tests) deteriorate unless kept in working order by intellectual activity? Most of the identicals reared apart who showed large differences were adults who had been out of school for years, while the identicals reared together were not over 18. There is a chance that the differences shown were due to occupation rather than to early environment. At least the question is worth settling.

#### FOSTER CHILDREN

It has appeared to investigators of heredity and environment that the careers of foster children offer good material for study. In contrast to own children, whose heredity and environment are supplied by the same parents, foster children get their genes from their own parents and their home environment from their foster parents. The two sets of influences are not so inextricably intertwined as in the case of own children. Foster homes at the present time are carefully selected by expert child-placing agencies and are doubtless much better on the average than the homes provided by the own parents. So far as intelligence and personality depend on early home environment, we should expect foster children to develop according to the level of their foster homes rather than according to the lower level of their own homes or of their own parents.

Besides the scientific interest there is a very practical need for discovering how well foster children succeed in life. The demand for children to be adopted exceeds the supply, and many couples wishing to adopt a child are from the educated sections of society whose own birth rate is low. If prospective foster parents are assured that by supplying a good home, excellent care and full opportunities for education they can rear a child to take the place which they would desire him to take in the community, without regard to the child's own parentage, this assurance will be highly important for the foster parents and for social control. On the strength of some positive findings which will have to be scrutinized in this report, the suggestion has been made that society, instead of seeking to minimize the fecundity of feeble-minded women, should utilize them as breeders of children for adoption into high-level homes. Such a proposal evidently calls for as thorough a checking over as would be given to

the design of a suspension bridge. Serious consequences would result from carrying out the proposal if parentage really counts for a great deal by way of biological transmission of potentialities. Society cannot afford to make a mistake here. Society can rightfully demand of its scientific workers a thorough investigation of the questions at issue.

Though closely interwoven, the scientific and practical interests in this problem are far from identical. Immediate practical interests are well served by investigations showing how foster children turn out when their parentage is inferior or unknown but when they have been carefully sifted by the placement agencies and distributed so as to match the child with the foster family as closely as possible. A scientific analysis needs to go much farther than this in the direction of separating environment from heredity. It needs to know heredity rather than merely parentage which is after all only a rough index of the individual's genetic constitution. And it needs to be assured that the child's foster home does not conform to his heredity, or else to know the degree of conformity present in the given sample.

Before proceeding to review the attempts which have been made to utilize foster children in the study of heredity and environment, it will be well to envisage the investigator's needs and to ask how far his requirements are met by the system of foster child placement.

*The investigator's requirements.* There are two ideal experiments: to apply different environments to individuals of the same heredity, and to apply the same environment to individuals of diverse heredity. Either hold heredity constant and let environment vary, or vice versa. Except in the case of identical twins reared apart neither of these ideals can be more than approximated in foster child studies.

Consider first what can be learned from *siblings who are*

*separated* and brought up in different foster homes. Their heredity is not identical by any means, but it is more alike than that of unrelated children. Resemblances that are due to heredity will persist in full force though the siblings are separated, while resemblances due to a common home environment will not be produced as they are in siblings reared together. In measurable traits, such as tested intelligence, the difference between separated siblings is compared with the difference between unrelated individuals, on the one hand, and on the other with the difference between siblings reared together. Suppose unrelated individuals, paired at random, to differ by 15 points on some scale of ability or personality, while siblings reared together differ by only 10 points. If now the separated siblings differ by 15 points, their common heredity is counting for nothing; but if they differ by only 10 points, the same as siblings reared together, then the environmental differences between the foster homes are counting for nothing. If the actual difference lies between 10 and 15 both factors must be having some effect and their relative importance can be estimated.

Of course the investigator would make certain sampling requirements. He would need a fairly large sample and he would be on his guard against biased sampling. He would insist that siblings be not systematically placed in similar homes. If he had complete control he might place them in radically different homes so as to bring out the full force of environment, but he would be satisfied if the placement were random. If, however, the truth is that siblings are usually placed in similar homes, the similarity of environment will be pulling together with similarity of heredity, just as in siblings reared together, and the recourse to foster children will be futile.

Consider next what can be done with *foster siblings*, who

are unrelated children brought up in the same home. Here environment is the constant and heredity the variable. If the common environment has no effect, these children will differ as much as other unrelated children, while if only environment counts they will be as much alike as true siblings reared together. Here again the sampling problem is serious, since the investigator wishes to assume that the foster siblings differ in heredity as much as children taken at random. If the truth is that each foster home gets children of similar parentage, the investigation is spoiled because heredity and environment are allowed to pull together.

An *orphanage* is a foster home and its inmates are in a sense foster siblings, unrelated children reared in a common environment. So far as the environment is the same for all, the differences among the children in an orphanage must be due to heredity (or to environment previous to reception into the orphanage). On the whole the orphanage children have been less subjected to divergent environmental pulls than the children of a community, and we should expect the scatter of intelligence, for example, to be smaller in an orphanage group than in a comparable control group in the community. The difficulty is to assure a control group that shall be truly comparable in heredity to the orphanage group. The object in this line of investigation is to hold environment constant and see how much the individuals differ because of heredity.

Conversely, let us take large samples of children, presumably equal on the average in heredity, and place them in *foster homes of different grades*. Place one sample in the highest class of homes and another sample in mediocre homes. (We cannot expect the placement agencies, just for scientific purposes, to place a sample in definitely bad homes.) If the sample placed in the better homes develops better intelligence or personality, some influence of environment is

demonstrated; but if the difference is smaller than that between own children reared in the two classes of homes, heredity also is a factor. By comparing the two differences we can obtain some estimate of the relative potency of heredity and environment. The method is obviously susceptible of amplification by the use of several grades of foster homes. The home environments can then be measured or rated in respect to income, parents' education, child care, etc., and the child's development correlated with these variables in the hope of discovering which environmental factors are of real importance. Children placed at a very early age can be compared with those placed at the age of four or eight years, so as to determine whether very early environment is as important as is often believed.

The sampling problem is somewhat different here. The investigator needs to have samples of equal heredity placed in homes of each degree of excellence. If the more promising children are placed in the better homes, heredity and environment will be pulling together and no direct conclusion can be drawn from the results, though adequate statistical treatment may still extract some probable conclusions provided a measure is afforded of the promise of each child at the time of placement.

A plan of investigation which escapes the difficulties of sampling consists in determining the *change* of the same individual resulting from a change of environment. The object is to hold heredity constant by using the same individual and to alter his environment. For example, measure a child's IQ before placement in a foster home and again after a year, two years, five years of exposure to the improved environment. A large sample of children is still desirable but each child's earlier and later performances are directly compared. The difficulty here lies not in the sampling but in the uncertainties

of the measuring devices, such as the intelligence tests for different age levels. The intelligence tests are a complicated empirical measuring instrument, depending for their validity on accurate standardization at the successive age levels. If the standardization has been imperfect a false appearance of change (or of no change) in the individual's IQ will be created. Since the tests are after all rather well standardized the errors from this source are not large in amount but they may be large enough, as some investigators have found, to make it uncertain whether foster children have or have not improved in their improved environment.

Intelligence testing in the first few years of the child's life encounters a more serious difficulty. We can put the infant through certain tests and determine whether his sensorimotor development is proceeding at the average rate, or how much accelerated or retarded he is in the development appropriate to his age. But we are not sure that the function we are measuring is the same as is later measured by the intelligence tests. Apparently it is not the same, since the infant tests do not enable us to make any close prediction of his IQ as it will be at the age of six years or later. Prediction is very poor even when the child remains in his own home (Hallowell, 1932; Furfey & Muehlenbein, 1932; Honzik, 1938; Bayley, 1940; J. E. Anderson, 1940; Cattell, 1940). If therefore a child tested in infancy and again after a few years in a foster home gains in test performance, we cannot be sure the change is due to environment.

(In a sense the individual's heredity changes as he develops; different hereditary potentialities come into operation. The adolescent boy's voice changes from a childish treble to a manly bass, not because of any change in the environment, but because a previously inoperative hereditary potentiality comes into play. The awakening of intelligence in the first

few years is probably a similar process. For one thing, it depends in part on the use of language, and intelligence testing is therefore difficult until the child has some mastery of this tool.)

Even when the child is old enough to be given a genuine intelligence test, he may be frightened or negativistic and fail to do himself justice, as has often been shown by experienced testing psychologists (as Updegraff, 1932). The conditions in which orphans and other dependent children are tested before placement must prevent many children from measuring up to their full ability. "The child is at a disadvantage, emotionally. He has just been turned over to the agency, usually following a traumatic experience such as loss of a parent, the breaking up of a home. He is in a hospital or temporary boarding home, pending a more permanent disposition of his case, and a psychometric examination is requested as an aid in determining his suitability for adoption or other placement" (Schott, 1937). Such is the comment of a psychologist well acquainted with the placement of children in foster homes. Even if the examining psychologist succeeds in obtaining good "rapport," an allowance of a few points in IQ would not be unreasonable, and the later test must show a gain of more than these few points to demonstrate any effect of the improved environment of the foster home.

Something of a dilemma confronts the investigator: If he studies the changes that occur in children adopted when they are old enough to be satisfactorily tested, he does not discover the effects of very early environment; if he chooses to work on children adopted in infancy his knowledge of the individual child's initial level is inaccurate. He cannot then place much reliance on pre-tests but has to judge the promise of the child from what he can learn of the child's own parents, their occupation, education, family background and perhaps

their tested intelligence. He has to use large samples and make his question somewhat less precise. He now asks whether children of inferior parentage placed in superior foster homes do better than children left in inferior homes, and whether they do as well as the own children of superior parents in their superior homes.

*How far do foster children meet the investigator's requirements?* The requirements in question are those of unbiased sampling. The investigator wishes to have foster children fairly representative of their own parentage, so that he may compare their intelligence and character after a stay in their foster homes with what could be predicted from their parentage. He wishes to have the children placed unselectively so that he can fairly compare the samples placed in foster homes of different grades and attribute any differences which appear to the different home environments. Since the investigator has no hand in the placing of foster children we need to look into the interests of those who do control placement. We have to consider the laws of the State, the policies of placement agencies, the desires of prospective foster parents and the desires of the child himself. As can readily be imagined these interests are not at all in line with the requirements of the investigator. We will consider briefly the populations from which foster children are drawn, the eliminations from these populations before placement, the question of selective placement, and the investigator's sampling of foster children after a period in their foster homes.

There are really *two populations* of children who are candidates for placement in foster homes. (1) Children who become available, not usually in the first months of life but at any age up into adolescence, are orphaned or deserted or judged to be neglected and maltreated by their parents, or their parents and other relatives cannot or will not support them.

A proportion of the parents have been placed in institutions for the insane, defective or criminal. The parentage of this class of children varies but on the whole is distinctly below the general average in education, economic competence, mentality and behavior. On the average it is safe to say that the children are of "inferior heredity," though it is a mistake to assume inferior heredity for any particular child because of his inferior parentage. (2) Children who become available directly after birth are usually (70-90%, according to the experience of Freeman's group in Chicago, of Burks in California, and of Skodak in Iowa) the children of unmarried mothers. Information regarding the fathers of these children is often lacking but the mothers are available for investigation (except in the case of foundlings who make up a small fraction of the whole number). The own parentage of these early-placed illegitimate children, so far as known, is quite variable but averages about on a par with the general population, some investigators (Burks, 1928) estimating it to be slightly above average, other investigators (Skodak, 1939) slightly below average though definitely above the parentage of legitimate children offered for adoption. The reasons for better parentage in the case of the illegitimate children are clearly stated by Leahy (1935). Whereas legitimate children usually become available for adoption because of incompetence of the parents and relatives, there are additional factors in the case of illegitimate children, such as the youth of many of the parents and the social stigma attached to illegitimacy.

From their parentage, illegitimate children would be expected to do better than legitimate children, when placed in foster homes—as they do; but whether because of better heredity or because of earlier placement in the foster homes it is impossible to determine in any direct way. The two populations from which foster children are drawn are incomparable

in several respects and investigators have been fully aware of the necessity of keeping them separate in statistical treatment.

Because of systematic *elimination* of children considered unfit for adoption, those who are found in foster homes and used by the investigator are not wholly representative of the parentage groups we have been considering. Prospective parents do not wish to adopt very unpromising children, and placing agencies have for many years taken care not to place a child until they are reasonably sure he is normal. The States, many of them at least, have provided by law for the safeguarding of foster parents in this respect. An Iowa sample secured by Skodak (1939) consisted of children who "were considered placeable by the placing agency, that is, were above 70 in intelligence quotient at time of placement, free from disease or gross physical disability." In Minnesota, "since 1917, annulment of adoption is possible if the child develops to be feeble-minded," and "a trial period of six months' residence in the home before adoption has been required by law. . . . Further, since 1925, a child has been regarded as unsuitable for adoption, if . . . one or both parents are feeble-minded or insane and the mental state of the child is as yet undetermined" (Leahy, 1935). For years there has been a growing tendency to avoid placing children who show mental retardation or behavior difficulties.

By *selective placement* is meant the placing of the more promising children in the better homes. So far as this occurs, heredity and environment are allowed to pull together and the investigator's aim to keep the factors separate is thwarted. Investigators have been awake to this danger and have sought to estimate the amount of selective placement in their samples. The efforts of the placing agencies have been directed to "fitting the child to the home," and with the older children they have been guided by the known intelligence and per-

sonal characteristics of the individual child. In placing children in the first year or two of life, the agencies have been compelled to fall back on rather vague indications of future ability and personality, such as the education and occupation of the own parents, and the behavior and test performances of the children at this early age. Investigators have believed accordingly that the placement of these very young children could not be very selective in spite of the efforts of the agencies. Prospective foster parents have seemed to be more interested in the personal appeal of the baby than in the question of his future ability.

One factor in the permanent placement of a child, however, seems not to have impressed our investigators as much as it has the placing agencies and the lawmakers. Though a child may be placed in a foster home at the tender age of three months, this placement is tentative. A trial period of six or twelve months, and longer if necessary, intervenes before the child is adopted. By this time the child has been under prolonged observation and may have reached an age when a satisfactory intelligence test can be given. In Iowa, we are told (Skodak, 1939), "since January, 1934, all children for whom legal adoption was sought, after at least one year of probationary residence in the foster home, have been given intelligence tests." Thus the foster family is guarded against adopting a defective or abnormal child. More than that, a family which sets great store on education and intellectual achievement has a chance to return a child which seems likely to be a misfit. "An important feature of placement in any sort of foster home by a responsible modern agency is its tentative character. Each placement, however carefully planned, is still essentially an experiment. . . . In some families the requirement that a child prove able to attain a certain academic and cultural level is of supreme importance. . . . Fortunately for

children who need foster homes, not all foster parents apply such standards" (Sayles, 1936). At this early age, to be sure, the indications of future ability are by no means definite; but if the superior foster homes manage to secure a disproportionate number of reasonably gifted children, and to avoid taking on those of inferior capacity, while homes of lower grades are less selective, the investigator's desire to have children of equal average heredity in all grades of foster homes will be frustrated to some extent. Checking up on their samples, some investigators (Leahy, Skodak) have found in fact a positive though rather slight correlation between own mother's education and the occupational level of the foster home, and the correspondence of heredity and environment will be closer if the foster parents have made good use of the trial period. How close it may be we cannot say. By carefully matching the IQ of child and foster parents—at a later age, however, than that of most adoptions—the correlation could be made even closer than holds on the average between parents and their own children. But the probability is that the actual placement of young children is far from being cleanly selective, for it often happens that children adopted by highly intelligent professional persons of superior economic status, and sent to the best schools, prove as they grow up to have only average intelligence (Hildreth, 1940).

*Obtaining the sample* of foster children and parents for testing is a process that may introduce sampling errors. The investigator secures from a placing agency a list of adopted children and endeavors to locate these children and win their foster parents' cooperation. A considerable number cannot be located, and a small proportion of those located decline to cooperate. The selective factors possibly operating cannot be evaluated accurately, and we can only hope that their effect has not been serious.

On the whole the sampling errors will probably not be large enough to obscure large differences due to environment, if such exist, but when the presence or absence of a small but real difference is crucial, the investigator will hardly be able to produce results convincing to the skeptic. The same can be said of the limitations of the intelligence tests; they are not serious when large differences are in question. Personality tests are at present much less adequate and have not been standardized so as to measure the child's development. They can be used for comparing groups of children at the same age, and when so used have failed to reveal any reliable differences between children in different grades of foster homes (Burks, 1928; Leahy, 1935).

For measuring the environment, also, the investigator still has no instruments known to be adequate. Certain objective data, as occupation, income, and education of parents, size of the house and yard, number of books in the family library, can easily be obtained, and intelligence tests may be given to the parents. But homes that rank low in these respects may still be intellectually stimulating to the growing child. Attempts have been made to give the home a rating for harmony, kindness, refinement, social interests, care and discipline of the child and facilities for worthwhile activities. These various ratings and indices can be combined into a total mark for each home, or the effort may be made to discover which of the variables is most closely related to the intellectual development of the child. The total mark for the home shows a moderate correlation with the foster child's intelligence, but there is little evidence on the relative importance of the component variables (Van Alstyne, 1929; Burks, 1929; Skodak, 1939).

On the whole we may expect results of considerable practical value, but of no great scientific precision, from the study

of foster children. We have no precise indication of the individual child's heredity—apart from his own performance which is dependent also on environment—and our samples are not demonstrably equal in heredity. Our measures of the environment are admittedly incomplete, and our measures of intelligence while more adequate than the rest still have their limitations. Perhaps the main difficulty is that the range of foster home environment is greatly curtailed at the lower end. It does not reach down into the jungle as we might desire for purely scientific purposes.

*"How foster children turn out."* The pioneer large-scale study of the careers of foster children came from the New York State Charities Aid Association (Theis, 1924). Without undertaking to make any scientific contribution to the nature-nurture problem, this large placement agency raised the question whether adopted children were making good to a reasonable degree, as a check on its own work and on the whole system of placing dependent children in foster homes. A follow-up study was made of the 910 children placed by the Association who had passed their 18th birthday. It was possible to locate all but 113 of these grown-up foster children and to reach a judgment whether they had developed into "capable" persons, whether their accomplishments to date showed them to have managed their affairs "with ordinary prudence." Few of these young men and women had "achieved anything out of the ordinary," but 77% of them could be fairly described as capable. About 20 of the young men and 20 of the young women had gone into teaching, nursing, minor executive work; a larger number of the men were in farm work and the mechanical trades, of the women in clerical work and domestic service. Of the 23% judged "incapable," about half were "harmless" though mentally inferior or shiftless and improvident, while the remainder, about 10% of the whole number located, could

be classed as more or less delinquent or vicious. On the whole, when the undesirable own parentage of a large share of these children was taken into consideration, the system of placement in foster homes gave encouragingly good results.

Though intelligence tests had not been made of most of these subjects, their school records made it possible to classify them into three groups: those able to go beyond the 8th grade (73% of the whole number), those able only with difficulty to complete the 8th grade (19%) and those obviously defective so far as academic work was concerned (7%). The proportion of dull and defective is rather large in comparison with the general population or in consideration of the carefully selected even if often relatively humble foster homes, but it is small in consideration of the own parentage of these children as a group.

The following statistics are interesting though far from decisive in relation to our problems of heredity and environment:

Of the children of good *own-family* background,

83% were "capable," and 93% able to go beyond 8th grade.

Of the children of bad *own-family* background,

71% were "capable," and 63% able to go beyond 8th grade.

Of the children reared in superior *foster* homes,

81% were "capable," and 82% able to go beyond 8th grade.

Of the children reared in mediocre *foster* homes,

85% were "capable," and 83% able to go beyond 8th grade.

The intermediate class of foster homes, which was much the largest, gave 80% of "capables," and 74% able to go beyond 8th grade; and the percents for the superior and mediocre classes of foster homes do not differ significantly from these values. It appears, then, that the grade of foster home had little to do with the scholastic or practical success of the children, while the *own-family* background was of considerable importance, especially in relation to scholastic ability. It must be noted, however, that many of these children had passed a

large share of their childhood with their own parents before coming under the influence of the foster homes. Of children adopted under five years of age, 30 were placed in superior homes and 25 in mediocre homes; and these small samples came out equally well in respect both to practical and to scholastic ability, though the children in the superior foster homes were carried much further along the academic road.

Besides classifying the foster homes as superior or otherwise on the basis of economic, educational and cultural status, the investigators estimated how well each home cared for its foster child. "Some mediocre families showed an unexpected degree of intelligence, understanding and sympathy in the treatment of their foster children, and some superior homes bungled completely the delicate problem of child training. . . . In evaluating the kind of care, it was necessary to consider not only physical care but the degree to which the family understood the child and allowed him to follow his own bent, rather than forcing him into their own mould." We might say that it was the interaction of child and environment which the investigators were attempting to evaluate. They found a definite relation between home care and practical success in life:

<i>Kind of care</i>	<i>% "capable"</i>
excellent	87
average	80
poor	66

Though this pioneer study made little use of tests or finely quantified estimates, it was perhaps more adequate than any of its successors in respect to sampling, for it was able to obtain returns from nearly 90% of the individuals in question. Another merit is seen in that the subjects had reached adult age. If the showing of the foster children is less favorable than in later studies, the reason probably lies in the smaller amount

of elimination that was practiced in the earlier years of child placing.

*A Chicago study of foster children.* The National Society for the Study of Education, a research organization, secured two extensive studies of foster children for their *Twenty-Seventh Yearbook* (1928), which was devoted to the problem of "nature and nurture." One study was conducted at the University of Chicago by Freeman, Holzinger and Mitchell; the other at Stanford University by Burks. The Chicago group set about "to determine whether the intelligence of the child is affected by the character of his environment." Without denying the influence of heredity they were inclined to stress the importance of environment wherever possible and to combat the view "that the degree of intelligence possessed by the individual is fixed by inheritance and determined at birth." Burks formulated her problem somewhat more broadly: "To what extent are ordinary differences in mental level due to nature and to what extent are they due to nurture?" Analysis of her data led her to rate the importance of heredity far above that of home environment as a source of individual differences. Being so different in emphasis the two investigations have often been regarded as antithetical. Actually their *findings* are in pretty good agreement, as probably the authors themselves would acknowledge.

The Chicago group, with the assistance of the Illinois Children's Home and Aid Society, were able to see and test 401 foster children and many of their foster parents and to rate the excellence of the foster homes. With the total group and a variety of subgroups they tried several of the plans of investigation which we have listed.

The pre-tested group furnished the clearest results. There were 74 children who had been tested before adoption, largely because of a suspicion of low mentality or because their own

parents were known to be defective. The pre-test had been given at the average age of 8 years and thereupon the accepted children had been placed in foster homes where they remained for 4 years on the average before the second test. Their IQ averaged 91.2 in the pre-test, and 93.7 after 4 years in the foster homes. The apparent gain of 2.5 points needed some correction because of imperfect standardization of the Binet tests at that time, and the authors applied a (perhaps generous) correction of 5 points, bringing the estimated mean gain up to 7.5 points. Schott (1937) found a similar gain in a Michigan sample but was inclined to attribute it to emotional upset during the pre-test and the greater feeling of security after the child had been taken into a foster home. So we cannot be sure that the gain of 7.5 points is genuine.

The Chicago sample included considerable numbers of separated siblings (reared in different foster homes) and of foster siblings (unrelated individuals reared in the same home). By heredity alone the separated siblings should resemble each other as much as siblings reared together, and the correlation between their IQs should be .50; by environment alone it should be 0. Foster siblings, on the contrary, should show a correlation of 0 by heredity alone and of .50 if environment alone is what makes ordinary siblings resemble each other in intelligence. The correlations obtained were intermediate between 0 and .50 in both cases, being .25 for the separated siblings, and .37 for the foster siblings. (This difference is not significant.)

When separated siblings were found in foster homes of unequal excellence, the child in the better home commonly showed a higher IQ, 6 points higher on the average than his sibling in the poorer home. When a high-grade family having an own child took in a foster child as well, the own child turned out to have an IQ of 112 on the average, the foster

child of only 95. "Adopted children are considerably lower in intelligence than own children in the same homes. It is probable that the difference is due partly to heredity and partly to early environment"—the foster children having been taken at the average age of 4 years, 8 months. This conclusion is judicious enough but the data do not rule out an interpretation in favor of either heredity or environment alone.

The total Chicago sample of 401 foster children, placed at the average age of 4 years and tested at the average of 11 years, gave a mean IQ of 97.5, which appeared to be very good in view of the inferior parentage of these children. And the children placed in better homes did better than those in average or poor homes, as shown in the following tabulation:

114 children placed in good homes got a mean IQ of 106.8
186 children placed in average homes got a mean IQ of 96.4
101 children placed in relatively poor homes got 88.9

But there were several other variables complicating the picture and making it difficult or impossible to see the exact relationships. The better homes tended to take the younger children, and the younger children came from better parentage, a large share of them being illegitimate. The youngest children have the best heredity, are placed in the best families, and are exposed to the good environment from an early age—and turn out to have the best intelligence. However, when the sample is limited to illegitimate children placed in the first two years of life, a relation to the grade of foster home is still in evidence:

45 illegitimate children in good foster homes got a mean IQ of 112
39 illegitimate children in average foster homes got a mean IQ of 105
27 illegitimate children in poor foster homes got a mean IQ of 96

The authors give careful consideration to the possibility of selective placement of these young children and conclude that it could not have affected the results appreciably. There

was some of it, but not enough, they feel sure, to bias the sample. There was also some elimination of defectives, but not enough, the authors believe, to raise the level of the sample seriously. We cannot be sure, however.

In the total sample, there were 120 children with one own parent reported to be mentally defective; the mean IQ of these children was 93. There were 26 children with both parents reported as mentally defective, and the children's mean IQ was 81. They were not themselves low enough to be called defective in most cases. Years ago, when mental defect was considered a simple recessive Mendelian trait, such a finding would have been regarded as impossible, but geneticists would now agree that the common type of mental defect is not a simple recessive. There was some evidence that the longer these children remained with their defective parents, before placement, the lower was the children's later IQ. Again the results are easily interpreted as the joint effects of heredity and environment.

*A California study of foster children.* The structure of the Burks investigation (1928) was relatively simple. She restricted her study to adopted children placed within the first year of life (mean age at placement, 3 months), with a control group consisting of own children in homes matched with the foster homes in locality and occupational level. The control children were also matched in age and sex with the foster children. All the children, the foster parents and the control parents were given a Binet test and the homes were rated for material and cultural level. There were 214 foster children and 105 control children.

From the (rather meager) information available regarding the own parents of the foster children, it was estimated that they should run about average, with a considerable scatter. The estimate was based on the occupations of the known par-

ents and on the probability of a small amount of elimination of the most unpromising children. Of the known fathers and employed mothers, well over 50% were in such professional, executive, clerical or skilled occupations as usually produce children with an average IQ of over 100. The author assigned 100 or a few points higher as the average IQ of the foster children to be expected from their own parentage. With regard to selective placement, careful consideration led her to believe it could not have occurred to any significant extent.

The mean IQ obtained for the foster children, when tested at ages 5 to 14 after spending practically their entire lives in good foster homes, was 107.4. The excess of about 7 points above the IQ predicted from their own parentage is accepted as the effect of the good home environment. The mean IQ of the control children, in matched homes, was 115.1. With equal environmental advantages they surpassed the foster children by about 7 points which are attributed to superior heredity.

The environmental effect of 7 points estimated from this study is just about equal to the effect suggested in several phases of the Chicago study.

Now if the environmental effect is 7 points and the additional effect of good heredity is 7 points, can we not estimate that heredity and environment have equal effects? A superior environment operating on children of correspondingly superior heredity gives an IQ of 115, and operating on children of average heredity gives an IQ of 107.4, halfway up from the general mean. Therefore the environment alone does half as much as heredity and environment combined. This rough-and-ready reasoning would probably not commend itself to a statistical expert. At any rate it is altogether too much dependent on that great unknown, the average heredity of foster children. From what is known of their own parents it would

not be unreasonable to predict for the children a mean IQ of 105 instead of the estimated 100; and then the effect of environment would be only 2 points, less than a third of the residue attributed to heredity. Evidently we ought not to allow our evaluation to depend on such an uncertain quantity as the heredity of the early-placed foster children. Either we must (in future studies) somehow manage to secure pretty close estimates of the average heredity of our sample, or else we must use some form of analysis that does not depend on any assumed value of heredity. The latter attack was the one devised by Burks.

The analysis depends on the fact that the foster homes, though all good, are not uniformly so. They differ in material and cultural advantages, in the intelligence and education of the foster parents, and along other dimensions. If selective placement is negligible, the children placed in different grades of home are equal in heredity, and any difference developing between them must be attributed to environment. Own children in an equivalent range of homes will show differences due to the conjoint effects of heredity and environment. Therefore we find the correlation between child's IQ and environmental variables, for foster children and again for own children. Some of these correlations, corrected for attenuation, are shown below:

*Child's IQ correlated with home variables*  
(Burks, 1928, p. 285)

	<i>Foster children</i>	<i>Own children</i>
Father's IQ	.09	.55
Mother's IQ	.23	.57
Material advantages of home	.24	.48
Cultural advantages of home	.29	.49
Income	.26	.26

Except in regard to Income, the foster child's correlations are much lower than those of the own child. Those for the

own child run near the usual figure of .50, those for the foster child run somewhere near .25. By the multiple correlation technique (combining the various environmental indices with such weighting as will give the maximum correlation with child's IQ), Burks reached an estimate of the correlation with total home environment of .42 for foster children, and of .61 for own children.

By inspection of these correlation coefficients it may still appear that environment has at least half of the force of heredity and environment combined. But correlation coefficients are tricky things and do not lend themselves to such direct comparison. The most approved method of using them in the present type of problem is by "analysis of variance." The "variance" of a distribution is the square of the standard deviation, and the contribution of any correlated variable to this variance is proportional to the square of the correlation coefficient. Let the variance of IQ in the given sample of own children be designated as 1.00 (or 100%). Part of this variance is due to the difference between homes or families, heredity and environment pulling together in the case of the own children, and giving a correlation of .61 between home and child's IQ. This inter-family variation in heredity and environment combined accounts for  $.61^2 = .37$  of the variance of own children. The remainder of their IQ variance ( $1.00 - .37 = .63$ ) is not accounted for by the difference between families; it must be due to factors not included in the inter-family variation. These other factors that account for more than half of the IQ variance are such as operate within the same family to make siblings differ, and they operate also in the community to produce a gifted child in a poor home, a dull child in a good home, etc. These other factors are not considered at all in the foster child studies, since these studies necessarily fix their attention on differences between homes. They take the

home as a unit and seek to determine the shares of heredity and environment in producing the differences between children in different homes. They are concerned, then, only with inter-family variation.

Our problem then is to analyze the 37% of IQ variance which is accounted for by inter-family variation in heredity and environment combined. In the case of foster children (with no selective placement) inter-family variation operates only as an environmental factor. It shows a correlation of .42 with the foster child's IQ, and thus accounts for  $.42^2 = .18$  of the IQ variance of the foster children. Now the variance of the foster children in the whole sample is equal to that of the own children, the standard deviation of each distribution being 15 points, about the same as in the population at large; and accordingly the 18% of IQ variance due to inter-family variation in environment (in the case of foster children) is directly comparable with the 37% due to heredity and environment combined (in the own children). We can say, then, that 18% of the IQ variance of the own children was due to inter-family variation in environment, and that  $37 - 18 = 19\%$  was due to inter-family variation in heredity. The shares of heredity and environment, *as between families*, still seem to be about equal.

The limitations of these estimates should be carefully noted. The PE (probable error) of these correlation coefficients is about .06, and they might probably enough come out somewhat differently in other samples of own and foster children and so alter the estimated shares of heredity and environment. Any selective placement (and the present reviewer is unable to believe there was none at all) would account for some of the correlation of foster children with their homes and so reduce the proportion assignable to environment. But the principal limitation to notice is that inter-family variation

in heredity and environment combined accounts for less than half of the IQ variance in the population.

The contribution of inter-family variation in environment to the IQ variance of the population is about the same when thus estimated from the foster-children data as when estimated from identical twins reared apart, p. 19. The IQ difference between identicals reared apart averaged 8.2 points which comes down to about 7.2 points when corrected for chance errors of measurement. The IQ difference between unrelated children in the community, paired at random, has sometimes been found to be 15 points, but probably should be a little larger, say 17 points. The squares of these differences would be proportional to the population variance and to the twin variance, the latter resulting from inter-family environmental differences which are perhaps about as great on the average as the differences between families in a community. The square of 7.2 is 18% of the square of 17, the same as estimated from foster children. Of course neither of these estimates can be regarded as at all precise.

The use made by Burks of her correlations is essentially the same as we have given, except that she does not stress so sharply the distinction between inter-family and other factors in IQ variance. She proceeds to estimate the shares of heredity and environment in the 63% that remains unaccounted for and inclines to attribute much the greater share of it to heredity, concluding that "probably, then, close to 75 or 80 percent of IQ variance is due to innate or heritable causes." Though she has some good reasons for this estimate, they do not issue directly from the data and she admits they are not "beyond cavil."

The author puts together in an interesting way the foster-child correlation of .42 with the home environment, and the foster children's estimated gain of 6 points (reduced from 7.4 to allow for the probability that the foster children were a little better than the average in heredity). The foster homes were on the whole superior to the average American home, yet they were not all of the very best. Suppose their average was above the general average by the amount of 1 Standard Deviation of the whole distribution of excellence in home environments. Then the correlation of .42 would enable us to predict for the foster children an IQ lying .42 of the IQ standard deviation (15) above the general mean. As .42 of 15 is 6 points, the computations check. Assuming a normal distribution of home excellence, and a linear relationship between home excellence and the child's IQ, we could then say that 68% of the homes would affect the IQ by not over 6 points, up or down; that 95% of the homes would have an elevating or depressing effect of not over 13 points; and that only the very exceptional home, one in a thousand, would be good enough to raise the child's IQ by 19 points, or bad enough to lower it by the same amount. The difference in the environmental effect of practically the best and the worst homes to be found

would accordingly amount to twice 19, or 38 IQ points. The author allows, then, for very substantial environmental effects in exceptional cases, though even a range of 38 points is far smaller than the total range of at least 150 points to be found in the population. All these estimates are of course only rough approximations, introduced mainly to emphasize the fact that differences in home environment account for only a minor part of the differences in intelligence within an ordinary community.

By further study of the correlations of foster children with particular environmental variables it should be possible, as Burks suggests, to work out the relative potency of the various factors.

*A Minnesota study of foster children.* The investigation by Leahy (1935) was carefully planned along the same general lines as the one by Burks. Matched foster-child and control groups, 194 children in each, were compared. The foster children, located by aid of the records of the Children's Bureau of the State Board of Control, were all illegitimate, all placed in adoptive homes at the age of six months or younger, and all from 5 to 14 years old when tested. The children were given the Stanford-Binet test, and the foster parents as well as the parents of the control children were given a paper-and-pencil intelligence test and a vocabulary test. The homes were rated for occupational, economic, cultural and educational level.

The investigator was keenly aware of the possibility of elimination and of selective placement. No low-grade defectives would be placed, and no children of feeble-minded or insane parents could be placed at the early age of six months. The probability was that the foster children would come out rather better than the general average, and in fact their mean IQ was 110, the same as that of the control group.

With regard to selective placement, Leahy had scarcely believed it would be possible when the children were placed so early in life, but she found statistical evidence that placement was based partly on the own mother's education and so was selective to a certain extent.

The foster children used in this study had been placed in families of the various occupational levels, except that those placed in farm homes were excluded so as to have a town or city environment for all the children alike. The control children were matched with the foster children in sex and age, in the occupational level of the home, and approximately in the education of the foster and control parents. On being tested the foster and control parents proved to be nearly identical on the average in intelligence and vocabulary scores. In economic, material and cultural rating, however, the adoptive homes proved to average slightly above the control homes, so that the adopted children had a slight advantage in total environment. But the range of environments was practically the same for the two groups. Range, or scatter, is the important thing, since the question at issue is whether the correspondence of child's IQ and home environment is equally close in the two groups.

This question receives some answer from a table of the mean IQ of the children from the different occupational levels, in the foster-child and control groups.

*Mean IQ of foster children and of own children in homes  
of different occupational categories*  
(Leahy, 1935, p. 285)

<i>Occupation of father</i>	<i>Foster child's IQ</i>	<i>Own child's IQ</i>
Professional	113	119
Business management	112	118
Skilled trades and clerical	111	107
Semiskilled	109	101
Relatively unskilled	108	102

In the column for own children we see the usual decline in mean IQ as we descend the occupational ladder. In the foster-child column we see a trace of the same effect, but only a little. We see, then, that the correspondence of child's IQ with father's occupation is much less close in the case of foster

children than of own children. The probable reason is that the own children's heredity corresponds more or less with their environment, whereas this correspondence is lacking in the foster children, except so far as selective placement may have occurred.

Neff (1938) has singled out for comment the unusually high mean IQ of the unskilled occupational group of foster children (own children from this occupational level have usually shown a mean IQ nearer 96), and has suggested "that foster parents, operating under the knowledge that the children are not their own, may take greater pains in providing the best social and cultural environment that is within their power." This is a reasonable suggestion but it does not explain why the foster children from the higher occupations fail to reach the usual level of those occupations. Foster parents from all occupations are picked with some care by the placement agencies, and the foster parents in the lower occupations have more than the average education for those occupations. But it is also true that the foster children assigned to the lower occupations will average somewhat better in heredity than own children from those occupations, except so far as selective placement has operated; and it is certainly true that the least promising children were not placed at all.

Another comment on the above table will be in order. In noting the differences between occupational groups of own children, one is likely to forget that the scatter within each separate group is almost as large as in the whole population. The intra-group SD (standard deviation) runs about 13 IQ points, while the SD of the whole population is about 15 points. The individuals in each group differ almost as much as the individuals in different groups. This means, again, that the occupational level of the parents—whether operating by heredity or environment or both—is only a minor factor in

determining the intelligence of own children, even; and the table shows that it is a still smaller factor in the intelligence of foster children.

The total home rating, dependent on occupation, economic condition, parental education, and material, cultural and social level of the home, should be a much finer measure of the child's environment than is afforded by occupation alone. Leahy's study included such a rating of the home, and when it was compared with the individual child's IQ, the correlation measured .23 for the foster children, and .53 for the own children. Squaring these coefficients, as was done with those of Burks, gives only 28% of the total variance of own children attributable to the inter-family variation in heredity and environment combined, and only 5% attributable to inter-family variation in environment alone, leaving 23% due to inter-family variation in heredity. Quite possibly the multiple correlation technique would have raised these two correlation coefficients and given estimates closer to those of Burks.

*An Iowa study of foster children.* The Child Welfare Research Station at the State University of Iowa has inaugurated what is planned to be a continued longitudinal study of the mental development of children adopted at an early age. So far, Skeels (1938, 1940) and Skodak (1939) have reported the early phase of the study. The principal sample consists of 154 children, mostly illegitimate, placed in foster homes under six months of age, left there for a probationary period of at least one year, then given an intelligence test because wanted for adoption (test given at average age of 2 years, 7 months), and retested at the average age of 4 years, 4 months.

As the intelligence of these children is always going to be compared with what would be expected from their parentage, it is necessary to form as exact an estimate as possible of the intelligence of their own parents. Regarding the education of

their own mothers we learn that 14% of them had less than 8 grades, while 33% had completed high school (12 grades) and a few had gone farther. The average number of grades completed by the own mothers was 9.9. The corresponding information is available for less than half of the own fathers; their average was 10.2 grades completed. From the educational record one might judge the parentage to be at least up to the general average of the population, but the authors believe that "the actual achievement was probably considerably below the school grade attained" (Skodak, p. 40).

Regarding occupation, a large share of the known fathers are classed as "day laborers," a few were students and the remainder were scattered through all the occupational levels. In view of the presumable youth of many of the fathers and of the economic depression in the early thirties when the matings took place, it is not strange that in many cases the father was actually unemployed. The large class of so-called day laborers may include a number of young men of average intelligence who had not yet succeeded in establishing themselves. Regarding the occupation of the own mothers the information is meager. A few were students, a few teachers, others were waitresses, factory workers, store clerks, telephone operators; and quite a share had done housework only. There is nothing here to furnish an estimate of the average intelligence of the mothers. The social status of many of the mothers was distinctly low and the average is regarded as fairly low.

Intelligence tests had been given to about half of the own mothers, and their IQs ranged from something like 60 to something like 130, with only 35% (instead of the regular 50%) above 100, and with an average of 93. (These IQs have been corrected to conform to an adult CA of 15 years.) The untested half of the mothers were believed from their education and occupation to be about on a level with those tested.

Apart from the question of parental status there was a chance for elimination of especially unpromising children. A child suspected of feeble-mindedness would not be placed for adoption, and the probationary period made it possible to return children that appeared subnormal. No report has been given on this phase of the question.

On the whole there seems to be little ground for assigning this sample of children a lower average heredity than the similar samples of Burks and Leahy. We might predict that their mean IQ would be about 100, or a little higher because of the eliminations. The mean IQ of those who passed the first test and were placed for adoption was 116 at an average age of 2 years, 7 months. Retested at an average age of 4 years, 4 months, the same children got an average IQ of 111.5. The apparent decline may be mostly due to the frailties of the intelligence tests for young children. Even the second test cannot be accepted as showing the final level with any exactness, and the results of further tests will be awaited with interest. Meanwhile the indication is that the children of unmarried mothers, after elimination of the least promising, measure up to the general average or a little better, when brought up from the start in good foster homes. The result is quite in line with those of the earlier investigators. Within a margin of a few IQ points all the findings are in agreement.

Considerable publicity has been given to the results obtained with 16 of these children whose own mothers had been "diagnosed as definitely feeble-minded on the basis of other criteria" besides the intelligence tests. According to the latter the mothers' IQs ranged from about 55 to about 79 with a mean of 71. On the average these mothers had completed 7.6 school grades, and the fathers 9 grades. "The social histories of the true families were strikingly poor." These 16 children were placed in homes which, though good, were not up to

the general run of foster homes. When tested at about 2½ years of age, these children showed an average IQ of 116; when retested at just about 5 years, their average was 108.

Sometimes these results have been hailed as proving that children of feeble-minded parents placed in a good environment will become as intelligent as the children of professional parents reared in their own excellent homes. Such a conclusion is open to several criticisms.

1. The second test of these children is on all grounds more trustworthy than the first, and in the second test the average is well below that usually found in the children of professional parents. And the second test, still, was given at too early an age to warrant any confident prediction as to the later intelligence of these children.

2. The sample of 16 children is much too small for safe conclusions. Further cases have been found at Iowa and are reported to have yielded "similar findings" (Stoddard, 1939). The number could have been considerably increased by including the cases reported in the Chicago study (see above, p. 52.) Both these investigations prove definitely that *some* children of mentally defective parents develop normal intelligence when reared in good homes.

3. The sample is certainly selected—selected, that is, by the placement officials who must not place a child known to be feeble-minded (Skodak, p. 70) and who would scarcely place a child of a feeble-minded mother until they were reasonably sure the child was normal. How many children of feeble-minded mothers were *not* placed we are not told, and consequently we have no basis for computing the expectancy of low, medium and high intelligence in children of defective parents.

4. The own mothers of these 16 children, according to their education and IQs, belong rather in the borderline than in the definitely feeble-minded group.

5. To do justice to present knowledge, a distinction should be made between different types of feeble-mindedness, since their genetics are very different. In particular, a mother whose defect is due to injury received at her own birth should be considered separately. In any such case there is no reason at all for expecting poor heredity in the offspring.

In general, these studies of the children of feeble-minded parents do not show that placement agencies can safely let down the bars and place children without regard to their parentage. What the studies show is, rather, that the agencies have been doing pretty well under the restrictions which they and the law have imposed. Before policies are radically relaxed it would be well to let investigators progress some distance farther in exploring the genetic and environmental factors in feeble-mindedness.

Returning to the whole group of Iowa children placed in foster homes in the first six months of age we observe that Skodak was quite alert to the question of selective placement. She found that the agencies had made serious efforts to place the most promising children in the best homes, but it appeared that the prognostic indices were very meager. Own father's occupation and education, own mother's education and (in some cases) her IQ were obviously utilized. With mid-parent education (average years of schooling for father and mother) as an index of the intellectual level of own and foster parents, the correlation between these two was .30, revealing rather a small amount of selective placement.

Skodak's data made it possible to compute the correlation between the child's IQ, at the age of about four years, and midparent education both own and foster. (Because the range of own parental education is smaller than that of foster parent education, a correction is needed before the correlation coefficients are compared. The reviewer has corrected the correlation with own midparent education, raising it from .33 to

.43.) The correlations were both rather low but that with own parents was the higher of the two.

Thus we have the following correlation coefficients ( $r$ 's):

Child's IQ and own midparent education	$r = .43$
Child's IQ and foster midparent education	$r = .18$
Own and foster midparent educations	$r = .30$

In view of the correlation between own and foster parents, an inference that easily suggests itself is that selective placement has brought children of better heredity, on the whole, into the better foster homes, and that the correlation between child, and foster parent is thus explained. It is refreshing, if somewhat amusing, to find the Iowa group drawing the reverse inference and concluding that the child's correlation with his own parents is due to selective placement. The variation in foster home environment is supposed to have made the children differ, and as the children of better-educated own parents were placed in the better homes, therefore these children obtained the higher IQs. Actually, so far as selective placement operated, the only sure conclusion is that the factors of heredity and environment cannot be disentangled.

However, the fact that the child's correlation with his own parents is higher than that with his foster parents would make it logical to attribute the larger influence to heredity. If we use partial correlations to eliminate the probable effect of each factor in turn we obtain the following results.

Own-parent education being held constant, the correlation of child's IQ with foster-parent education comes down to .06.

Foster-parent education being held constant, the correlation of child's IQ with own-parent education comes down only to .40.

The "path coefficient" statistical technique gives us practically the same estimates of the direct influence of own parents and foster parents on the child's IQ. But the correlations are

so low that less than 20% of the total IQ variance of the children is accounted for by the variation in own-parent and foster-parent education combined. In spite of some excellent features in the setup the investigation, to date, seems to contribute very little to an explanation of individual differences.

It should be added that Skodak devised a home rating scale intended to furnish an estimate of the stimulating value of a home to the child, and obtained ratings of about  $\frac{2}{3}$  of the foster homes. The correlation of this home rating with the child's IQ reached the substantial amount of .49, but for some reason little emphasis was laid on this result. The scoring of the home admittedly depended a good deal on the subjective judgment of the investigator.

The Skodak report includes a study of 65 children placed in foster homes somewhat later in life, from 2 to 5 years of age. They had been taken from inadequate own homes, kept for a time in an orphanage, given intelligence tests and placed largely on the strength of a satisfactory showing in the tests. Their own parentage was inferior to that of the preceding group who were placed soon after birth. The mean IQ of these children was 98 shortly before placement, and 104 after they had spent an average of a year and a half in their foster homes. The gain of six points is approximately the same as has been found or estimated in previous studies.

Placement of these older children was somewhat selective, being based on the child's IQ. The correlation of child's IQ with foster parents' education was .36 at time of placement and .28 after the year and a half in the foster home. So far, then, there was no evidence of a differentiating effect of the home environments. The children are still rather young. The question of a cumulative effect of home environment, for good or ill, has been in the minds of several of the investigators without getting any answer even halfway satisfactory.

Another unsettled question concerns the age at which environment exerts its greatest effect on the child's intelligence. The usual assumption has been that quite early years, perhaps from 2 to 6, are the most formative. Because the children who are placed in the first year or two (many of them illegitimate) have better parentage and are adopted by better homes than children placed later, evidence on this question has been difficult to obtain, though the Chicago study contains some slight evidence in favor of the usual assumption. According to a report by Skeels (1940), however, children left in poor homes show little change up to the age of 8 or 9 and decline in IQ from then on. Unless some selective factor comes into play here, the indications are that home environment is most decisive in the latter years of childhood. Of course it remains possible that some children decline in IQ as they approach maturity, not because of inadequacies of the environment, but because their type of mentality does not run to the more abstract thinking demanded by the intelligence tests at the higher levels.

*Foster children: discussion and summary.* Before we leave these studies we may glance at the results from a somewhat different point of view. We have thought of them as studies of environment, but they are also tests of the foster child's heredity. When we say, as we are apt to do, that children of "poor heredity," placed in good foster homes, turn out fairly well in spite of their heredity, are we not asserting the impossible? No one can achieve anything that is beyond his potentiality. If a child, from whatever parentage, develops superior intelligence, we know for certain that his heredity was good enough to make that achievement possible. We have simply been misjudging his heredity. The low economic and cultural level of his parentage has misled us. We have forgotten that the offspring of any given parents may differ widely in genetic

constitution, and we have forgotten that these particular parents because of their own early environmental handicaps are probably functioning below the level of their hereditary potentialities. The more we stress the importance of environment, the less are we justified in inferring a child's heredity from the social status of his parents, and the less are we entitled to speak of a child as having "poor heredity" just because his parents are poor, uneducated, shiftless and immoral. Placement of the child in a good home gives him a chance to show how good his heredity really is. What the foster child studies are doing, when seen from this angle, is to check up on the heredity of the offspring of certain classes of parents. Possibly the distribution of hereditary potentiality in the children of a socially inferior group is the same as in the population at large.

A check on this possibility could be made by providing an average environment, or better, for a fair sample of children born into the inferior group. In a sense the foster child studies have been making such a check—but quite inadequately, we must say from our present angle. First, because the own parentage of the foster children has never been adequately examined and defined. And second, because the sample has never included *all* the children of the given parents. Elimination has always occurred before the children were placed and adopted, and the investigators have not known how much their results have been distorted by this elimination.

From the results as they stand we can safely say that a large share of the children, from the ill-defined social group that relinquishes their children, have about average heredity in respect to intellectual capacity. But whether this social group produces its quota of well endowed children, and whether it does not produce an excess of the poorly endowed, are important questions that remain unanswered. The investigators

have not had these questions in mind. The questions they have asked and the answers so far obtained are as follows, in summary.

1. Does improved environment raise the intelligence of children? An average gain of 5-10 points has been observed in several studies, though always with some possibility of explaining it away.
2. What is the relative importance of different environmental factors in the child's intellectual development? The correlations suggest that the cultural level of the home is more important than the economic level.
3. Does the difference between homes—the inter-family variation in environment—account for most of the variation in intelligence found in the community? So far as home environment has been measured it appears to be a minor factor, though about on a par with the inter-family variation in heredity. The main causes of variation seem not to be such as differentiate one family from another in environment, or in heredity either. The causes, genetic and environmental, which make siblings differ seem to be more potent than those which differentiate one such family group from another.

#### INSTITUTIONAL HOMES FOR CHILDREN

There are several good reasons for appending to our review of the foster-child studies a brief consideration of the possibilities of research on children reared in institutions. Any complete investigation of children relinquished by their parents should include those who are retained in orphanages as well as those deemed suitable for adoption. Orphanage children have usually been found to average low in intelligence, but how far from a selective factor tending to leave the less promising children in the orphanage, and how far from the unstimulating orphanage environment we do not know.

Orphanages must differ among themselves in both respects. Some follow the policy of placing all promising children for adoption, while others retain all their children up through the school years. Some are intellectually unstimulating from the paucity of adult contacts available to the children, while others are probably not inferior to the private home in this respect. Mooseheart is a shining example of the latter class (Reymert & Hinton, 1940), though it is not strictly an orphanage since it admits dependent mothers along with their children; its personnel includes more than one adult for every two children. In some orphanages the ratio is nearer 1 to 25.

Orphanages are rather in disrepute at the present time because children adopted into private homes have been making a much better showing when tested or when examined with respect to personality traits. Even in Russia where institutional care for dependent children was adopted enthusiastically after the Revolution, policy has more recently turned toward placement in private homes (League of Nations, 1938, I, p. 32). The causes of the inferior showing of orphanage children are obviously open to debate, especially as the findings differ in different institutions and as the scatter of intelligence within the same institution is sometimes as great as in the population as a whole. It would seem that a survey and comparative study of institutional homes for children would be instructive, and that some of these institutions would cooperate in an experimental study of the relative importance of such environmental variables as are subject to control.

A special reason for making some reference here to institutional homes is that the Iowa study of foster children, which we have considered at length, is bound up with other studies in which this group of investigators is attempting to demonstrate the effects of environment on the growing child. The Iowa findings are believed by the investigators to present a

consistent picture of large changes in intelligence resulting from changes in the young child's environment.

*Nursery schools.* The series of investigations began with a study of the records of a "preschool laboratory" or nursery day school conducted at the State University of Iowa since 1917 —a pioneer among nursery schools and undoubtedly a very good one. The children were drawn largely from the families of the University staff and other professional men. Their mean IQ was in the neighborhood of 120. These little children were tested on entering the nursery school and retested toward the end of the school year. From test to retest they gained nearly 7 points, on the average of a large number of records. The changes showed a wide scatter, from a gain of about 45 points to a loss of about 35, but on the average there was the considerable gain mentioned. (See summary by Wellman, 1940, with references.)

These changes in the first year of nursery school had been observed from the beginning of the work at Iowa but the gains had been attributed to the child's "habituation to experimental conditions, practice, increased facility in the use of language, and mental stimulation" by the nursery school activities. The later Iowa investigators have attributed the changes almost wholly to the nursery school, while other psychologists attach much importance to the factor of habituation or adaptation. The child is tested the first time in a relatively strange place, but retested in a place where he has come to feel at home. The importance of adaptation is suggested by some of the findings: the gain was as great for children whose attendance had been only a part of the year as for those who had had practically a whole year of the school. There was, however, some additional gain in the second year of those children who remained, bringing up to 10 points the

total average gain attributed to the influence of the nursery school environment.

Psychologists connected with other nursery schools were eager to discover whether similar gains would be shown by their children, and quite a number of reports on this question can be found in the 39th Yearbook of the National Society for the Study of Education, 1940, Vol. II. The mean gain has been from 2 to 5 points in a year of the nursery schools.

The use of a control group would seem essential so far as the purpose is to check on the specific value of the nursery school. Wellman (1934-1935) reported from Iowa City that children, presumably of parentage similar to that of the nursery school group, showed no rise in IQ during these early years but, if anything, a decline of a few points. Accordingly it seemed safe to attribute the entire gain of the nursery school children to the influence of the school. Other investigators have often found some gain in the control group which cancelled out part of the gain of the nursery school group. The consensus of opinion at the present time would probably be that no appreciable gain in IQ accrues to children with good homes from attendance at even an excellent nursery school. A gain in social and personality traits may very likely occur. Stoddard (1940) has urged, however, that the use of a control group is misleading. The gain is real, he holds, and the fact that it occurs in excellent homes as well as in nursery schools simply shows that there is more than one type of stimulating environment for young children. He seems to have given up the original contention which attributed the gain of the nursery school child to the *change* in his environment, the change from his presumably excellent home to the still more stimulating school environment. Unless we can ~~accept~~ that older contention we obtain from the nursery school data no

evidence directly bearing on the problem of heredity and environment. We simply know that children of good heredity and environment tend to show a rising IQ in the preschool years.

Besides the evidence from averages, Wellman (1938) laid great stress on certain individual cases. A little girl on entering the nursery school at the age of 3 years gave an IQ of 89, but half a year later her IQ was 118 and thereafter it remained in the superior brackets. According to the strict environmental hypothesis advanced by the author, this child's home environment must have been mediocre and the nursery school produced a large, quick change in her mentality. But no information is furnished on this child's home and parents, nor regarding the other individual cases brought forward to show the large effects of environment. There were some cases showing large declines in IQ which logically should be attributed to the depressing influence of the school on children from certain homes; but no analysis of these cases is offered. If individual cases are to be brought into the picture—and probably they could be with advantage—they obviously should be presented as case studies and not as a mere series of IQs at different ages.

*The "leveling" hypothesis.* A very interesting suggestion emerged from the Iowa nursery school studies. The question arose whether the nursery school would have the same effect on children who were high, medium and low in intelligence on entrance. The children were therefore segregated statistically according to their initial IQs and the change in average IQ was worked out for each class. It was found that children initially below 100 showed a large average gain, and that children initially above 140 showed a large average loss, while children initially around 120 neither gained nor lost on the average, their gains and losses balancing each other. It was

therefore concluded that 120 IQ, approximately, represented the proper level of that particular environment, its level of intellectual stimulation, and that all the children tended to come together at that level. The level of a nursery school would be determined partly by the adults present, partly by the material facilities, and partly by the interaction of the children themselves. The bright children entering the group would raise the level, the dull children would pull it down, and the resultant of all these forces would pull the individuals together toward a common level of mentality. (A serious thought for the parents of the very brightest children!) Life in a certain environment would therefore have a leveling effect, and the existence of such an effect seemed to be demonstrated by the retest results already mentioned—by the coming down of the initially highest and the coming up of the lowest.

The "leveling" hypothesis makes sense, certainly, but the evidence adduced for it is irrelevant and worthless for the purpose. The evidence consists simply in the well-known "regression toward the mean" (Goodenough and Maurer, 1940). Unless two tests show perfect correlation—and even a prompt retest never does that—the individuals in the top bracket in the first test are bound to scatter somewhat in the second test and to obtain a lower average standing in the group distribution. Those in the lowest bracket will come up on the average, while those in the middle will scatter in both directions. Regression has nothing to do with the time sequence of the measurements; it works backward as well as forward. From the scores in the second test pick out the individuals who stand highest, and trace them back to the first test: you will notice that some of them came from positions lower down in the distribution; and those finally in the lowest bracket have come in part from higher up. Thus the same data that show leveling show the opposite also, both appearances being statistical

artefacts and both being predictable from the fact that the correlation of the two tests is not perfect.

But, it may be argued, these effects must be due to real causes; calling the effect regression does not take it out of the real world. Yes, but the causes are variable and without any general tendency, either upward, downward, centripetal or centrifugal. When an effect is predictable from the interplay of such causes it obviously affords no evidence of the operation of a determinate cause. We shall have to return to this problem in a moment.

Regression, than, neither proves nor disproves leveling. But a perfectly sound check on the hypothesis is available (McNemar, 1940). If a group is being leveled, its individuals are becoming more alike, and its scatter or dispersion (measured by the SD of its distribution) must be getting smaller. The present reviewer would rather expect to find some such shrinkage of the distribution, but the data so far presented in support of leveling do not show any shrinkage at all. Results from an outstanding nursery school in Detroit, brought forward as evidence for leveling, show regression very nicely, but the SD of the distribution of the children's IQs was 16 points after as well as before the children had spent a year or more in the school (Starkweather & Roberts, 1940).

*Iowa orphanage studies.* An orphanage would certainly have a lower intellectual level than a select nursery school. The records of two orphanages were examined by the Iowa investigators. In one the mean IQ of the children was about 85; and the children below this level tended to gain on retest while those above tended to lose. In the other the level was about 90, the children below gaining on the average while those above showed some loss (Crissey, 1937). This is regression again. Whether the SD of the distribution decreased or not cannot be told from the published tables. With the orphan-

ages were compared two schools for feeble-minded children; their average IQ was about 62 and some regression toward this mean probably took place but was obscured by a general tendency for the IQ to sink, a tendency noted in other institutions for the feeble-minded. This decline can be interpreted as a tendency toward some low level, but it can be interpreted in other ways as well and affords no positive evidence for leveling.

A considerable number of unpromising children were transferred from the orphanages to the schools for the feeble-minded. Since they went from a higher to a lower level of environment they should register a decline after the transfer. On the whole they did show a slight decline, 3.5 IQ points. A few children, judged to be improperly placed, were transferred from the feeble-minded schools to the orphanages; those under six years old when transferred showed no consistent change while those over six gained a few points. These results of changing the environment afford some small support to the leveling hypothesis.

Another device for testing the leveling hypothesis was used by Crissey. It is the device of "matched groups." To convey the idea let us suppose that identical twins are placed, one in an orphanage and the other in a school for the feeble-minded. The leveling hypothesis would predict better mental development for the twin placed in the orphanage. No identical twins being available, suppose two children are first tested and found to have the same IQ, and then placed in the two institutions. The same result would be expected, except that more chance variability would enter so that a considerable number of matched pairs would be used. So an experimentalist would proceed and his experiment should provide sound evidence for testing the hypothesis. But the investigator here is not in the position of an experimenter. He is not in the way of plac-

ing children. He does have access to the records of the orphanage and of the school for the feeble-minded, and he notices that the IQ distributions of the two populations of children overlap. The orphanage distribution centers about 85 but extends from 135 down to 45; and the feeble-minded school centers at 62 but extends from 35 up as far as 95. So he is able to match cases drawn mostly from the lower part of the orphanage distribution and from the upper part of the feeble-minded school. That is, he finds in the records two children, one in each school, who on being tested at nearly the same age obtained approximately the same IQ and he asks how these children compared when retested a year later. He matches as many pairs as possible in this way, and he finds that on the average the retest IQs of the orphanage children are 6 points higher than those of the matched children in the lower environment. He has the result predicted by the hypothesis of leveling. Yes, but the same result would occur without any leveling just by the action of the variable forces that give rise to regression. The children from the lower part of the orphanage distribution would tend to rise on retest, and the matched children from the upper part of the feeble-minded group would tend to fall. The thing would work backward just as well and prove the opposite of leveling; that is, match cases by the second test scores, pairing children from the lower part of the orphanage distribution with children from the upper part of the feeble-minded group; then, going back to the initial tests we should expect to find the orphanage cases averaging higher than the others. So we should show that the children in the orphanage had been declining in comparison with the children in the feeble-minded group.

If the above explanation has an air of hocus-pocus, a word more on the subject may be in order. An individual who repeats the same performance many times will vary more or less

up and down from his own mean. On a certain occasion he will fail to do himself justice; on another he will outdo himself. If he happens to outdo himself on a first test he is likely to go down somewhat on retest. If a hundred persons are tested, those who have outdone themselves will not all be in the upper bracket, to be sure, but the upper bracket will contain a disproportionate number of those who have outdone themselves and who will not do so well on retest. Therefore the individuals in the upper bracket, taken as a whole, will not do so well on retest, relative to the group as a whole. Besides the fluctuations which occur from moment to moment and from day to day there are irregularities of growth rate and accidents of experience which enter as variable factors in comparing test and retest separated by a year's time. All these variable factors act to lower the correlation between test and retest, to increase the regression, and to spoil the method of matched groups in its non-experimental form.

Possibly the leveling hypothesis would fare better if level were estimated in terms of Mental Age instead of Intelligence Quotient. The IQ, as a ratio of Mental Age to Chronological Age, gives an idea of the child's rate of mental development up to the time of the test. Mental Age measures the actual level reached by the child at a given time. It seems rather absurd when dealing with a group varying considerably in Chronological Age to speak of them as at the same level if their IQs are the same, in spite of the differences in Mental Age among them. Some indication that the Mental Age of the personnel is a better measure of level than their IQs is afforded by the experiment of Skeels & Dye (1939). Finding in the orphanage a number of babies whose development was retarded and whose IQ—as measured by the infant tests—ranged from 35 to 89 with a mean of 64, they placed these young children as "guests" in a school for feebleminded girls. The

IQs of these girls ranged from 33 to 80, no better than those determined for the babies, but the "girls" were grown-up women with Mental Age ranging from 5 to 12 years, far above the children. These feeble-minded girls were able to provide mental stimulation fully adequate to the needs of the children. They took an eager interest in the babies and gave them plenty of stimulation. The children developed well and some of them were soon measuring up to an average IQ or higher. The striking gains of some of the children are evidence, as much as anything, of the unreliability of infant intelligence tests, but the experiment at least showed that feeble-minded women are capable of providing adequate mental stimulation for babies of average intelligence; and this is probably not the first time that a feeble-minded nurse has done a good job, under general supervision, for a child of normal intelligence. The experiment can also serve to cast doubt on the belief sometimes held that a feeble-minded mother will so depress the IQ of her child in the first few years as to handicap him for life. A moron mother with a Mental Age of 9 or 10 years is certainly a match for an average child of preschool age.

*The nursery school in an orphanage.* In one of these orphanages a very interesting experiment was tried by the Iowa group of investigators (Skeels, Updegraff, Wellman & Williams, 1938). Permission was obtained to set up a nursery school for about half of the very young children, the other half being left as a control group. The school took its group of children out of the orphanage environment for six hours a day. The school was well equipped and well staffed. If the nursery school in Iowa City could so improve the environment of the faculty children as to raise their IQ by an average of 10 points, how much more might be accomplished by taking children for the school day out of the very unstimulating orphanage environment! For while good care was being taken

of the health of these preschool children, little attention was being paid to their mental development. They had little contact with responsive adults, little opportunity to learn the language or to pick up information. They were regimented, not taught to take care of themselves, and they had almost no toys and no individual property.

The nursery school group were given experience in taking care of themselves, in active play, in listening to stories and music, in looking at picture books, playing with toys, talking to adults and exploring the neighborhood under supervision. The nursery school undoubtedly did something for these children and the experiment was a success to the extent of convincing the authorities that such facilities were needed in an orphanage. But as far as the IQ is concerned the gain was not sensational, amounting perhaps to about 5 points in a year. The nursery school group went up 4 points and the control group down 1 point. Over a longer period these changes were apparently slightly greater but the remaining groups were very small. (The data are not so presented as to show the consecutive IQs of the individuals or groups. In fact it is impossible for the critical reader to find answers to the obvious questions or to check on the authors' general conclusions. These conclusions are that the orphanage environment was causing a gradual decline in the children's intelligence—"leveling" toward feeble-minded or borderline status—and that the nursery school succeeded at least in arresting this decline and turning it into a slight rise.)

One conclusion to be drawn is that a satisfactory experiment of this sort cannot be carried out in an orphanage devoted largely to the placement of children in foster homes. Children deemed suitable for adoption are placed as soon as good foster homes are offered. In the Iowa experiment there was frequent elimination of children from the nursery school and control

groups, and it was impossible to keep any considerable number of children in the school for more than a year. There was no chance to demonstrate the effect of a three-year period, as had been planned. And the constant elimination of the more promising children, with retention of those who seemed to be developing poorly, introduced selective factors that might easily affect the statistical results.

The results of the Iowa experiment with a nursery school in an orphanage are rather less clear than those of an earlier experiment of the same sort carried out in a Chicago orphanage by Barrett & Koch (1930). A group of young children that were given nursery school privileges, and a control group of matched children from the same and other orphanages, were tested before and after the period of 6-9 months of schooling. The nursery school group made a net gain of 16 IQ points. Part of this gain was explained by increased familiarity with the test materials, some of which were similar to play materials used in the nursery school; but a part was probably "attributable to a rise in the general experience level of the nursery-school children through such channels as improved motivation, the development of attitudes of independence, initiative, inquiry, confidence, etc., and increased information, as well as improved motor skills."

*Constancy of the IQ.* The Iowa investigators have repeatedly urged that their findings dispose of the belief in "constancy of the IQ," the belief, that is, that the individual's intellectual status, in relation to his age, remains fixed throughout life. Undoubtedly the degree of constancy of the IQ has been overestimated by those who took the average reported change for a maximum. But if the average change amounts to 5 points up or down, changes of 10 points will be common enough, changes of 15 points will occur once or twice in a hundred cases, and even changes of 20 points may be expected

occasionally. The still larger changes sometimes reported are based mostly on initial tests at a very early age which admittedly have little predictive value. These variations do not destroy the fact that the IQ is on the whole a relatively stable measure. It is then urged that the usual constancy of the IQ is due to the constancy of the environment and that any marked change in the stimulation value of the environment would soon change the IQ. The question then becomes one of evidence—evidence that will convince the skeptic—and one of quantity of change. The Iowa studies seem to provide confirmatory evidence of relatively small changes, rather than to alter the picture radically by demonstrating much larger changes due to determinate environmental causes.

A small gain in the intelligence quotient, however, is not to be despised. We must remember that a gain in IQ means much more, if it is permanent, than a certain increment of knowledge or skill. It represents an increment in the child's rate of mental development, an increment which will produce cumulative gains in knowledge and skill even though the IQ remains constant after its first rise. Suppose a child of just average hereditary potentiality, such as will give an IQ of 100 in an average environment, has been reared so far in an unstimulating environment and has developed mentally only 90% as fast as the average child. His present IQ, then, is 90. Introduced into an average environment, he will need a little time to adjust himself to the new tempo of mental life and to make up for lost time, but after a year he may come up to an IQ of 100. Presumably he will continue to function at that level and to develop at the average rate, so that his IQ will remain 100 and he will become an average instead of a somewhat below-average adult. The gain would be well worth while, and the question whether such a gain can be dependably produced by improved environment de-

serves much more incisive investigation than it has yet received. For we have very little scientific knowledge of the environment. We do not certainly know which environmental factors are important in mental development. We do not know that the nursery school is any better for the young child than free play about the home. We do not know whether an orphanage is necessarily inferior for the older child than the average home or whether it might not be made quite superior.

#### CONCLUSIONS

As the preceding survey has found repeatedly, there are serious difficulties in the way of separating the factors of heredity and environment when our interest lies in such traits as human intelligence and personality. There are sampling difficulties, inadequacies in even the best available tests for mental abilities, and much vagueness as regards the proper measures of environment. Also we have no direct indication of the individual's hereditary constitution, of his particular combination of genes. It is not to be wondered at if the results of elaborately planned investigations leave us unsatisfied and uncertain. A few findings do seem to be well assured.

Heredity and environment differ as between families, and also as between the children of the same parents growing up in the same home. By noticing how much siblings differ in comparison with children from the community at large we can estimate the total effect of intra-family variation in heredity and environment combined, as compared with the inter-family variation. We find the inter-family component in the total variance of the population to be smaller than the intra-family component. From the examination of foster children compared with own children in similar homes we

gather that the inter-family differences are due partly to differences in heredity and partly to differences in home environment and about equally to the two factors. That is, own children from different homes differ in part because their families have somewhat distinctive heredity and in part because the home influences are different.

As to the intra-family differences, the fact that there are some even between identical twins reared together proves that such differences are due in part to environment. But the relatively small differences between these twins leave the major part of the intra-family differences still undissected. Since siblings in general differ in heredity, they differ correspondingly in the effective environment, dependent as that is on their own characteristics. The environmental factors that differ as between children in the same home are often too subtle to be easily controlled or measured, and no promising beginning has been made toward estimating their respective shares in the production of individual differences. Differences between own children in the same home are sometimes the result of prenatal and natal accidents. But for the rest they are due to the combination or interaction of heredity and environment, and that is about all we can say at present.

The most striking feature of these results is the small share that can be attributed to inter-family differences in environment. Not over a fifth, apparently, of the variance of intelligence in the general population can be attributed to differences in homes and neighborhoods acting as environmental factors. The reason is probably to be sought in the large degree of uniformity of environment produced by the schools and other public and semipublic agencies. It is still possible that raising the intellectual level of the environment would

raise the general level of intelligence, while not by any means annulling the individual differences due to heredity.

The gains of foster children and of other children in changed and improved environments have been much less striking than might have been expected. About 5 or 10 points in IQ is all that can be claimed for the average gain, with much individual variation above and below this average. Even this amount of gain is not established beyond doubt —nor, to be sure, is it proved that still better environments would fail to register much larger gains. Somewhat larger gains and losses have indeed been indicated in some of the identical twin pairs who received very unequal educational opportunities.

An important result of several foster-child studies is the good showing made by many children whose own parents are rated very low in the socio-economic scale. Instead of saying that these children have made good in spite of poor heredity, we must conclude that their heredity was good or fair in spite of the low status and unsatisfactory behavior of their own parents. Their heredity was obviously good enough to permit them to do what they have actually done. By this test of accomplishment some children of feeble-minded parents are proved to have average heredity. But to infer that all or even most children of inferior parents are possessed of average heredity would be going far beyond the present evidence, because of the elimination of especially unpromising children that has always occurred before the samples were made available to the investigators. To assure a gifted young couple that they could do as much for the next generation by adopting any "normal" infant as by having a child of their own would be a scandalous exaggeration of the known facts.

## SUGGESTIONS FOR SOCIAL RESEARCH ON HEREDITY AND ENVIRONMENT

Though it might seem that social research would be interested only in environmental factors, a little consideration will indicate the desirability of cooperation between the social investigator and the geneticist. Without such collaboration the social investigator would be likely to work under false assumptions and to miss important leads.

Besides, the social scientist is certainly interested in such a problem as the genetic potentialities of different social groups. The genetic potentiality of an occupational class, or of the feeble-minded, or of the own parents of children who become wards of the State and are offered for adoption, is certainly a matter of social concern. Research on such a problem should start with the parents and trace the careers of all their children, so as to bring into view the entire distribution. The medical history of each child, including prenatal and natal conditions, would be essential. All the children in the sample should have at least a fair trial in a good environment. A long-time, follow-up study would be necessary.

A distinctly environmental line of study has been suggested several times in the course of this review. Instead of resting content with studies of "the environment," some one should get to work seriously in an investigation of specific environmental factors. So far as has been revealed, the economic level of a home is less important for intellectual development than the educational or cultural level. Still more important for the child's success in life, according to some of the evidence, is the proper "care of the child," the adjustment of the home environment to the native characteristics of the child. Some of these specific environmental factors could be examined by

the method of "co-twin control," and others by experiments conducted in orphanages and other institutional homes which have a fairly stable population of children and which are alive to the criticism directed against such institutions.

As one active investigator has said (Jones, 1940), "It seems probable that we shall turn from retrospective surveys of conditions assumed to have had a prior influence, and shall prefer to deal with the current and cumulative effects of specific environmental factors. It may also be expected that our interest will shift to some extent from mass statistical studies . . . to investigations of the dynamics of the growth process in individuals." The investigation is bound to be developmental if it is to be adequate. It need not be limited to early child development, since we have found some indications that late childhood and early adolescence are still favorable periods for environmental influences. The environment best adapted to successive stages of development remains to be discovered. The hypothesis of "leveling," though not supported by any present evidence, has too much inherent probability to be discarded without further investigation.

In closing we suggest a few projects of rather broad scope which may deserve the consideration of those who feel the great need of further investigations in human heredity and environment. It is now feasible and desirable for geneticists, psychologists, cultural anthropologists, educators and sociologists to join forces in studying the interplay of genetic and environmental factors in social adjustment.

1. Studies of twins. A register of all twins born over a five-year period in the United States or in some large section of the United States would provide available data upon which important studies could be undertaken on unselected samples of twins.

(a) The sample of identical twins reared apart could thus be enlarged.

(b) Identical twins reared together in childhood but separated in adolescence or at the beginning of adult life would provide evidence on the importance of environmental influences operating after the period of childhood.

(c) Identical twins reared together but studied progressively during their development could throw light on the differentiation of role that sometimes takes place in such pairs of twins, and on the effects of this differentiation on abilities and personality traits.

(d) Studies by the method of "co-twin control" could examine the effect of specific environmental factors.

2. Foster children. Instead of waiting till some years after children have been placed in foster homes it should be possible to follow them along from the start. The primary requirement would be a close collaboration of a placement agency with a group of investigators. It would not be necessary or desirable to follow all the children; for scientific purposes it would be better to limit the study to cases in which full data could be secured regarding the own parents, the medical history of the child, and the level and conditions of the foster home. If possible a long-time study should be planned and provision made for following these children up into adult life. This study could be made to serve several research purposes.

(a) By including in the study *all* the children of the own parents of the foster children (whether retained by their parents, placed out and adopted, or sent to institutions) the investigators could determine the expectancy of the offspring of the given class of own parents. The point would be to know the hereditary potentialities of children from this class of parents.

(b) Attention could be directed to environmental factors at the time of their operation, rather than simply in retrospect.

(c) When siblings are placed in different foster homes, a follow-up study would reveal whether there was a progressive divergence, in correspondence with the difference of their foster homes.

(d) When two unrelated children are adopted into the same home, a similar study would show whether they became progressively more alike. A well-controlled study of such foster siblings would be of great value in the statistical analysis of heredity and environment.

(e) When a family having its own child adopted a child of about the same age, an opportunity would be offered for studying the resemblance of these two children to the adults in the home.

(f) The study should not be limited to children placed very early in life, since it is important to know whether environmental improvement beginning at any age during the developmental period is successful in raising the level of the child's intelligence and personality. When the child is old enough to be properly tested before placement, a good opportunity is afforded for observing changes in the individual. To avoid obvious sources of error, it would be well to test the child both before placement and again as soon after placement as the child has begun to feel secure in his new home. Thus it would be known whether the improvement found in later tests was due to development of intelligence or to improved emotional adjustment.

(g) In a follow-up study such as is contemplated, special attention could be given to what has been called "care of the child," which we have interpreted as meaning an adjustment of the foster-home environment to the needs and characteristics of the individual child. Light could be thrown on the problem of "interaction of heredity and environment."

3. Orphanages. Present belief based on a certain amount

of evidence regards the orphanage as an unfavorable environment for the child, but the causes are not well understood. Two general projects may be suggested.

(a) A survey of institutional homes for children with a view to discovering the variations in their equipment and personnel and in their treatment of the children, with some estimate of the results achieved.

(b) Experimental studies in selected orphanages which retain their children for a considerable time, with a view to testing out the effects of specific environmental factors. For example, the amount of contact of the child with adults could be increased for certain children for the purpose of seeing whether this factor is important in mental development. It is conceivable that an orphanage could be run so as to become a decidedly favorable environment for the growing child, but at present we do not know how this result could be accomplished.

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